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CONTINUOUS LAND COMBAT

Technical Report 4940

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Abstract

This report presents the results of a study of continuous land combat, a concept of modern warfare made possible by the complete mechanization of land combat forces and the technology that enables effective combat at night, in poor weather, and under low visibility conditions. It is a logical extension of the blitzkreig warfare of the German Armies in World War II.

An abbreviated comparison is made of current U.S. perception of and capabilities for the conduct and support of continuous land combat with the land and air force needs to achieve that capability. A systems perspective was taken in examining combat and combat supporting functions and the essential elements of a continuous combat capability -- doctrine, organization, training, equipment and technology. An effort was made to gain the participation and input of those operational and development organizations that are concerned with various aspects of continuous land combat operations.

Preface

This report presents the results of the study of continuous land combat, a little understood but most vital concept of modern war that becomes possible with the complete mechanization of land combat forces and the technology that enables effective combat and movement at night. The work is an outgrowth of the DARPA/SRI study of Restricted Visibility Land Combat (RVLC), the conduct and support of land combat at night and in low visibility conditions -- bad weather, low ceilings, battlefield obscurations. It was perceived that when modern armies achieve the capability for effective night operations, they would have the potential to continue a high level of intense combat activity without stopping for those reasons that traditionally force a pause -- fatigue, night, logistics, reorganization, regrouping, and restoration. However, much more than the capability for night combat operations is required. Every aspect of land combat is affected. Fundamental and far-reaching changes in doctrine, organization, equipment, training, and research and development are necessary. A sharp point is put on the matter by the fact that continuous operations is a fundamental precept of Soviet doctrine and they have been working steadily since 1954 to gain that capability.

So many very well qualified and experienced professionals took time from very busy schedules to participate in technical discussions and present their operational and technical inputs on this most vital subject that it is not possible to list them individually. Their help is gratefully acknowledged. (The organizations are listed in Section 2.)

Within the Defense Advanced Research Projects Agency, Mr. G. D. Sullivan, who was the Program Manager of the RVLC study, initiated and tasked the continuous land combat effort and has been a constant source of professional guidance and support. Major T. G. Covington, U.S. Army, took over the responsibilities within the Tactical Technology Office of DARPA and provided positive and most helpful technical management of the project. The recommendations and technical input of R. A. Moore, Director, Tactical Technology Office, and D. A. Looft, Deputy Director, DARPA were very valuable. Their interest in this study was most encouraging.

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CONTINUOUS LAND COMBAT: SUMMARY

The Problem

"Once armies went into winter quarters and cut down their operational year by six months. Still armies go into night quarters and cut down their operational day by twelve hours. When are soldiers going to tumble to it that an army which can fight round the clock has a hundred percent advantage over one which can fight only half way round it?"/1/

The Soviets did, but extended their perception well beyond the 24-hour battle and in 1954 made continuous combat operations the main principle of their combat doctrine. They have been working steadily toward that goal. However, the capability for continuous land combat would evolve whether there was a Soviet threat or not.

The potential for continuous modern combat is made possible by the complete mechanization of land combat forces and the technical systems that enable effective combat and movement at night. But machines and technology provide only the potential; much more is required. The Soviet recognition of the advantages of continuous operations and their comprehensive body of military thought on the subject, all backed by hardware, simply add a sharp point to the matter.

There is essentially no U.S. capability for continuous land combat. Much more than the capability for combat operations at night is required. A TRADOC-initiated workshop on Night/Continuous combat concluded this and recommended that guidance in this important concept of modern land combat operations be provided in the new capstone Army Doctrine FM 100-5. This was not done.

The impact and implications of continuous combat are not fully understood by the combat forces of the U.S. or its NATO allies. Major and fundamental changes are required in every aspect of combat and the support of land combat -- doctrine, training, logistics, maintenance, organization, equipment, research and development (AC243 NATO Panel on Limited Visibility Combat).

Major Conclusions

- Continuous land combat is a concept of modern warfare that will evolve under the influence of the forcing functions of mechanization and technology; the Soviets have for a long time understood this, are working toward it, indeed may be almost there. The United States and NATO have resisted taking hold of the problem for many reasons, principally because the changes necessary are so far-reaching that the scope is not fully appreciated and there is considerable inertia to continue as we have in the past.

/1/ Maj. Gen. J.F.C. Fuller, "The Tank in Future Warfare," Brassey's Annual, 1952, Clowes, London.

* Doctrine for continuous combat is the most essential element. It has been recognized in FM100-5 that the first battle of a war in Europe would have to be fought by the combat forces there with the resources they have at the start of the war. This means that, above all, the forces in place must be organized, configured, equipped and trained to meet the Soviet continuous offensive, day and night, in any weather, and to meet conventional, nuclear, chemical and biological attack. Training derives from doctrine (as does everything else). It must be a common doctrine applicable and acceptable throughout NATO. It will be a coalition war, and interoperability of equipment, procedures, doctrine, communications, and command and control, is fundamental.

* Without overstatement it is essential, even critical to national security, that the significance of continuous combat operations be recognized, that the fundamental impact it will have on every aspect of land combat be acknowledged, and that a major DoD program be established so that this capability can be achieved in the shortest time. Clearly, the Army will have a primary role. However, the impact on air support and Marine Corps concepts of operations will be extensive. Major issues concern doctrine, organization, equipment, and training. Materiel development, which necessarily tracks closely behind doctrine, must be brought into balance so that there can be concert in the implimentation of operational and support capabilities. Combat and combat support are equally important.

* The scope of the DoD program should include: human factors and psychological conditioning for intense combat in a mass destruction battlefield environment; planned use of reserves (rotation, force echelonment, and the high mobility essential to implement rotation and relief concepts); logistics planning factors and resupply concepts particularly for bulk items -- POL, ammunition; the capability for extremely rapid organizational, tactical, and logistics planning, and for battlefield management in highly confused, fluid, and dynamic unremitting combat; combat service support to keep up with unprecedented losses of men and material; TOE revision to meet the extreme performance demands of continuous combat; maintainability of the ever increasing numbers of machines upon which modern land combat depends (design criteria for rapid repair, modular replacement, forward repair vice rear base dependence); alternatives to air base dependence for air support, resupply and reinforcement. All of the above will require comprehensive operational and field testing within service, intra-service, and among the combat forces of the NATO alliance.

The Implications of Continuous Land Combat

Fundamental to continuous combat operations are psychological and human factors considerations. These are particularly acute in nuclear, chemical, and biological warfare environments. Fear and inclination to panic is exaggerated by the fatigue and stress of combat, particularly when mass destruction weapons are used or threatened. The effects of fatigue pyramid both in victory and defeat. The victor is capable of extraordinary endurance; the negative effect on the defeated is also magnified in a way that has no counterpart in civil experience. Rotation or the echelonment of forces is necessary so that fresh troops are cycled to the point of combat contact. The ratio of crews to assigned combat vehicle is affected (i.e., TOE). Essential combat, combat support, and command and control must function continuously. Logistics are affected not only in volume but in class of materials. There is no precedent on which to base anticipated demands.

The tempo of operations will increase when the present discontinuous or intermittent operating capability is replaced by a sustained combat capability. The intensification of combat activity will reduce the time that is available to reach decisions. This will require changes in present doctrine for the organizational and logistic planning of an operation, the organization of the forces to be used, and the conduct of the battle.

Fuller understanding of the nature of combat under continuous operations will be necessary for the development of doctrine relating to the purpose, composition, and use of reserves. In an extended high tempo continuous operation, the regular relief of companies, battalions, and brigades must be provided for in the commander's plans. There might be a deliberate effort to shorten the duration of a continuous combat operation by committing most of the force with little held in reserve. Or an enemy capable of unremitting attack, organized to echelon fresh combat units to maintain momentum, may force the commitment of the reserve forces.

A continuous combat capability must be accompanied by continuous logistic support capability. Present logistic operating concepts and planning factors have been established to conform to the requirements and environment of a day-night daily operational cycle. The daily consumption rate of supplies will increase. However, the fact that a force may accomplish its mission in a shorter time may reduce the total amount of supplies required. New concepts for feeding troops and support units may be necessary. Concentrated high energy foods and endurance-prolonging drugs may be added to the ration.

Ammunition usage rates are largely based on experience. There has been no modern continuous land combat experience, not even in the 1973 Arab-Israeli War. For example, whether ammunition consumption by small caliber weapons will increase by any significant amount is not so certain. Large amounts of small caliber ammunition are now fired in night combat actions, especially by the defense. Much of this is blind firing. What of illumination rounds? If land combat forces are fully equipped with night devices, what is the value of illumination?

Continuous day and night operations will increase the maintenance requirements of a force. The intensified use of vehicles and weapons will accelerate wear and breakdowns. Since the overall duration of the campaign should be short, established maintenance and repair activities, as well as equipment and supplies, might be reduced or eliminated.

Continuous combat and supporting operations will establish new performance requirements for participating units. Present unit TO&E's, which have been based on long experience in non-continuous operations will have to be changed to provide the capabilities called for by this new mode of warfare.

Success in modern land warfare is increasingly dependent upon an ever growing number and variety of machines. These are ideally suited for the conduct of continuous operations so long as their needs for operating supplies, maintenance, and operators or crews are met. It can be noted that those forms of warfare that are the most highly mechanized -- naval warfare, air defense warfare, strategic air warfare -- are characterized by a continuous operating capability. In modern mechanized armies there will be comparable machines in opposing forces. The opponent who achieves the most efficient sustained utilization of his machines will have gained a distinct combat advantage.

Continuous combat operations will place extreme demands on commanders and their staffs. The traditional pattern -- conduct and supervision by day, planning and evaluation by night -- will not be adequate for the needs of forces engaged in continuous operations. The increased tempo can lead to rapidly changing combat, making it more difficult to keep aware of the battle situation and to control the combat and support units that are assigned.

How Long is Continuous?

Whenever continuous operations are considered a bounding condition is usually defined, such as up to 72-hours, or 3 to 5 days and nights without let-up, until a pause is forced by fatigue or logistics so that traditional concepts can apply and combat organizations as they are presently constituted suffice. It would then only be necessary for those combat units in the path of the offensive to exert extraordinary and heroic efforts with the resources they have in hand. No major changes in long-standing concepts of warfare would be necessary except for increased emphasis on night combat operations. This is precisely what is taking place.

This is not the kind of modern combat by tank heavy, mechanized forces that is presented in specific tactical detail in the Soviet military writings: Savkin's "Operational Art and Tactics,"; Siderenko's "The Offensive"; Sokolovskiy's "Soviet Military Doctrine"; Reznichenko's "Tactics"; to cite a few. In themselves, these and many other documents and exercise reports represent an important body of knowledge, not only about the enemy, but also of imaginative concepts of modern warfare in such detail as to suggest a great deal of work, development, and field exercises:

* The use of shielded formation lights on tanks and combat vehicles;

* Repair and maintenance forward by maintenance teams in specially equipped armored vans;

* Specially trained and equipped medical teams operating close behind the forward combat echelon in armored vehicles specially configured for the support of NBC warfare;

* When to don protective overgarments and who wears them;

* Crossing water obstacles in stride (without pause);

* Psychological training and conditioning for mass destruction warfare;

* The use of smoke and combined arms to defeat antitank and aircraft delivered PGM's;

* Procedures for the washdown of men and machines and the equipment for this purpose;

* The mechanized laying of pipe to maintain the high demands for POL;

* The meeting engagement as the likely mode of modern combat;

* The many uses of smoke and variable particle size aerosol generators in offense and defense;

* Decoy and deception;

* Helicopter operations by regular infantry troops;

* Air landings by heliborne forces at night in Motorized Rifle Battalion strength and larger, with equipment, deep in the enemy rear.

More significant, all of the above is backed up by equipment that is fully operational. Estimating intentions is an imperfect art. Hardware takes much longer to realize.

The Soviets have evolved the concepts and doctrine of the continuous offensive based on the writings of Guderian and Fuller and their experience in the Belorussian campaign. They document that overall numbers of combat personnel required and casualties expected are much fewer. The advantages to the Warsaw Pact of the continuous offensive are:

* Disruption of mobilization of NATO allies;

* Weakening of resolve of uncommitted nations;

* Deep penetration and confusion makes the employment of nuclear weapons by the defender more difficult;

* Reinforcements from the United States cannot arrive in less than eight weeks;

* Only a relatively few light forces can be transported by air;

* The war may be over and done before a nuclear decision is made.

Actuality of the Threat

The Soviet Military thought series becomes an actuality when the weapons and equipment that are essential to the implementation of that thought are developed.

Some examples:

Siderenko	"The offensive ... will be conducted night and day ... without let up until the enemy is defeated." All Soviet military vehicles have been made night capable since 1963, albeit with active IR systems initially. However, the equipment on the Israeli captured Soviet BMP-76 PB was an advanced passive image intensifier.
Chuikov	"No water obstacle in Europe or Asia will stop us." Soviet bridging equipment is acknowledged to be second to none and their forces are completely equipped.
Sokolovskiy	"An offensive should be mounted primarily in tanks, mechanized infantry combat vehicles, and helicopters. Dismounted attack will be a rare phenomenon." The BMP-76 BP is considered by many to be the most advanced infantry combat vehicle in the world today. It was made operational in 1967 and is the means to implement the projected mounted combat doctrine of Sokolovskiy.

When hardware is put into Soviet operational units to carry out what is projected in military doctrinal literature, there is in being a threat and a challenge that must be met or we will be defeated, if not in battle, then in negotiations. Intellectual estimates of intentions, the belief that the Soviets are mentally and technically inferior, that they do not train enough to do what they state in doctrine and have equipped themselves to do, that they are rigid, not flexible, and will fall apart if the basic operations plan is forced to change, that they are rail dependent and logistics limited, that only second-tier officers are assigned to logistics and therefore they will be unable to keep up -- all of these are opinions in justification of the reasoning that the

threat is less than the hardware forcibly indicates. Any or all of these points, which emerged in technical discussions in the course of the study, may or may not be true. None of these is so tangible or has as much meaning as equipment and weapons that can do exactly what is said. There is a cold finality in the existance of a weapon or machine of war that cannot be rationalized away.

This is not intended to suggest that the Soviets are "ten feet tall," another typical response to the presentation of measurable continuous combat actualities. They are not. Many Soviets are, indeed, 5'-6" tall by specification to fit into their low-profile tanks. But there are more than 40,000 tanks, all of them night capable, that can snorkel or swim, are equipped with self-contained navigation systems, with formation lights, have the ability to smoke, and which are completely equipped for NBC warfare down to protective overgarments as part of vehicle issue.

The Dichotomy

The fulcrum of Soviet combat capability, and hence the key to the threat to U.S. and NATO, is in their doctrine, training, organization and equipment for continuous combat operations; the sustained offensive. This salient point has become lost in "short war, long war" arguments, in terms like "ultra blitzkrieg", and in "bean counts" of men under arms and weapons, particularly tanks. There is a clear dichotomy in the organization, doctrine, and concepts of modern warfare between U.S. and NATO land combat forces and those of the Warsaw Pact. This is centered around the perception, impact, and implications of continuous combat -- the capability to maintain or resist the offensive by modern mechanized forces day and night and in poor weather and visibility, without let-up.

The Soviet concept is to echelon forces so that the intensity of the offensive can be maintained at the points of combat contact along the main thrusts. A unit is used up, exhausted, then replaced in kind by a fresh unit. Logistics, maintenance, medical, engineers and other essential combat and combat service support have organizationally been pulled back to Army or Front and are assigned to those units having the greatest need based on combat activity and objectives. It might be noted that the unit replacement concept is better suited for nuclear and mass destruction warfare, as well as for sustained conventional combat.

The U.S. expeditionary force concept is based on having division to a large extent, autonomous and self-sustaining. Each has its own share of logistics, maintenance, headquarters, administration, and other support personnel. Combat losses in men and materiel are made up from replacement pools. It is a concept that can work only if there is the opportunity to mobilize and equip for a war that would grind the enemy down by the sheer weight of the material strength and industrial capacity of the United States. It is appropriate for a long war, a war that the Soviets could not win. It is not suited to the completely mechanized sustained offensive, which is clearly projected by the Soviet posture, equipment, doctrine and military thought.

Why Not a U.S. Capability?

Facing the continuous combat operations problem, scoping it, and meeting it has been resisted, obscured, and putoff for various reasons, none of them valid. Some of these are:

* The threat can be met with nuclear weapons

* Continuous combat simply requires the capability to fight effectively at night. Or, an alternative to this, continuous combat involves much more than night operations, but first, attention must be given to night and, once this is done, then the broader, more extensive, and difficult problems implicit in continuous combat will be addressed

* U.S. technology is superior, and in technology lies the solution

* We cannot match the numbers of men and equipment of the Warsaw Pact and win without resort to nuclear war (the paradox is that the NATO countries have almost as many men under arms and spend more money on defense).

Reasons advanced for lack of a sense of urgency in the matter of the Warsaw Pact continuous attack threat -- nuclear, chemical, biological, conventional -- by well-equipped combat forces include:

* "The incredibility of conflict, it won't really happen." But it has in the entire history of man on this planet. It did in 1939 and it was just as incredible then. It will again; when is the only question. Lack of a credible capability, conventional as well as nuclear, invites a direct attack.

* "The Soviets don't really have this capability. What they write is for our consumption." Continuous combat has been established as the main precept of modern Soviet combat operations. Their doctrine of force echelonment has no U.S. or NATO counterpart and is specifically designed for continuous and nuclear combat. They have the equipment to carry it out: mechanized infantry combat vehicles to allow troops to fight while mounted since troops on foot can't keep the pace; water and obstacle crossing equipment without equal. All equipment -- air defense, communications, EW, logistics and maintenance, pipe laying, decontamination trucks and wash down equipment -- is on wheels or tracks and is equipped to move and fight at night.

* "They don't train any differently than we do." From this, presumably, it follows that, despite the doctrine and equipment they have irrefutably developed, they do not, because of training inadequacy, have the capability to do what they have organized and equipped themselves to do. But even if it were true that the Soviets do not train enough and are inflexible or logistics-limited, this does not alter the enormous advantage that can be had by the innovative military thinker who uses what mechanization and technology will allow -- intense, lethal com-

bat without pause or let-up in pace and ferocity. We could seize that opportunity if the much larger, better equipped Warsaw Pact armies have not.

* "We are already doing many of the things that you recommend." Of course, this would be expected. But this is part of the problem, for the things being done are related to aspects of "normal" land combat -- night operations, battlefield management, command and control. They are not being undertaken as a concerted effort toward this major concept of land warfare. There are, at present, no programs in the Army specific to continuous land combat. Yet at the same time, efforts on real time information, management and control of the battlefield, improvements in logistics and maintenance, and many other current actions, are pieces that would become part of the capability of NATO/U.S. land combat forces for continuous combat. The problem is that these are not being pursued within a common, consistent context. There needs to be, first, recognition and acknowledgement of the problem and the concept; then a concerting of doctrine, organization, equipment, training, and materiel development into balanced accomplishment. There must be a more consistent, directed alignment of actions to this end, rather than random alignment of actions in sometime support of sustained combat capability.

There was agreement among the professionals at the many technical and operational organizations where the problem was presented that the capability for continuous, mechanized combat operations is essential, even vital, in modern land warfare. However, positive doctrine and policy must be established if it is to be achieved. Other reactions can be summarized as follows:

* An attitude of doing the best that can be done to achieve combat effectiveness with what they have under the handicaps of:

  - The negative attitudes of Congress,

  - An ever-decreasing budget, fewer personnel,

  - The realities of the all-volunteer Army.

* A distrust of any study that might result in more technical gadgets because of bitter experience;

* Continuous combat (it is believed) would require twice the personnel -- where would they come from?;

* There are too many number one priorities;

* The Soviets can't do this anyway; they write what they want us to believe;

* Conviction that U.S./NATO forces will quickly be defeated by the larger, better equipped Warsaw Pact forces.

Night Operations First, Then Continuous?

There is an easy misconception that night and continuous operations are one and the same. Reports, lesson plans, manuals are often labeled "Night/Continuous Operations" which furthers this notion.

The recommendation of a Combined Arms Center study group was that Army efforts should first focus on gaining a capability for night operations then go on to the more difficult goal of continuous operations. However, it can be argued that the capability for effective night combat operations will never be achieved as a benchmark that can be looked upon as the departure point for then concentrating effort on continuous operations. This "night first" conclusion simply establishes a common direction of effort for operational and technical organizations toward night combat operations and provides an easy reason for putting off coming to grips with the much more difficult and pervasive problems of continuous combat.

As land combat becomes more lethal, mechanized, and independent of ambient light, it can be expected to evolve as have other forms of machine-dependent combat. It is suggested that day and night combat will become nearly the same, and that it will become more lethal and far-ranging in the context of target acquisition, weapon delivery, and mobility. The character of combat will change from an infantry to a mechanized orientation; soft targets, in the open, unprotected by armor, will not survive nor influence combat; dismounted combat will be the exception; the meeting engagement, according to Sokolovskiy, will be the usual form of combat encounter; troops will fight from inside tanks, combat vehicles, even helicopters; troops on foot will be unable to keep up. Historical trends are all in that direction.

U.S. Army Forces Command established the requirement that one third of all training be done during hours of darkness. This has been assigned a number one priority. However, the commanders to which the responsibility has been assigned already have too many number one priorities. They are also made fully accountable for safety, as well as, hard, tough training. Artificialities in the name of safety, like "vehicle headlights on," "man with a light walking in front of combat vehicles," "no movement of company-sized and larger units," work against the hard, tough training objectives and result in "make work" exercises that are resented. Enlisted personnel, officers and commanders feel that more training, as much as one-half of all training, should be done at night, and that the quality of training must be improved, that is, be made specific to the demands of modern combat and be "how-to-fight" scenario oriented.

Logistics, maintenance, medical and other combat service support do not normally practice at night with the combat units they support except in major exercises. Since continuous land combat is as dependent on continuity of support as it is on continuity of combat operations, training demands for night and continuous combat must apply equally to combat support units.

Fatigue, restoration, and resupply problems characteristic of con-

tinuous operations will not occur in sporadic night training. The diurnal, very marked decrease in effectiveness, which is a function of the biological rhythm of the human animal, will be encountered only in extended continuous day and night training. However, family, garrison, and community responsibilities work against this kind of training.

The Impact on Air Support

The air support of continuous land combat operations in Europe is generally considered not to impose new requirements. But it does, and many of the problems are the same and are as far-reaching as those that affect land combat.

NATO and U.S. combat aircraft have only a limited night capability. Close air support and interdiction at night and in poor weather will rest on aircraft like the F-111E, a very small fraction of aircraft resources.

The requirement to operate day and night will rapidly exhaust high skill maintenance and operational personnel, particularly pilots, even if battle losses and damage were not a factor -- and these will be of an unprecedented magnitude, briefly seen in the Arab-Israeli 1973 war.

Driving enemy aircraft out of air may not be sure. We have acknowledged superiority in pilot experience, training, and capability. But modern Soviet aircraft are excellent machines. They have more than a two-to-one advantage, and air combat has become largely dominated by air-to-air and surface-to-air missiles. Soviet missiles have been deadly effective in combat.

Close air support doctrine, which is embodied in the A-10, enables retail delivery of ordnance in repeated attacks on demand by Forward Air Controllers from heavily loaded on-station CAS aircraft. This will not be workable against Soviet mechanized forces defended by mobile gun and missile air defense weapons in numbers and lethality never seen before. Because of avionics and weapon delivery limitations of CAS aircraft, night and periods of low visibility (prevalent in Europe two-thirds of the time) are essentially conceded to the enemies' mechanized forces.

Most critical to continuous combat is the dependence on air bases for sustaining operations, deployment of REFORGER units, Tactical Air Command squadron augmentation, and delivery of supplies. The threat to these bases, critical to NATO defense, will range from conventional air attacks to assault at night by heliborne forces in battalion strength and larger. Harassing attacks by SSM's and aircraft can also impair air base effectiveness. Nuclear attacks can be even more devastating.

Continuity of Support

Continuous combat requires continuity in every essential element of combat support and service support and not simply in the combat function. While this is obvious, it is in the combat service support func-

tions where peacetime pressures and attitudes influence adoption of administrative procedures and methods, as well as equipment, that is best suited for peacetime efficiency. These are usually opposite to the wasteful, redundant, and throwaway requirements of combat.

The modern concept of continuous, lethal, furiously paced and fluid combat exaggerates the extremes between peace and war modes of operation. A most vital consideration is that there will not be the time to transition from "production line" maintenance, overhaul and rear base concepts of operation to the forward, highly mobile, tailored-to-the-situation kind of operations demanded by continuous combat.

Some Considerations That Apply to Maintenance and Logistics

Maintenance and logistic support considerations for the continuous land battle include the following:

* Repair, resupply, and service support forward in the immediate combat zone, probably at night, in a nuclear environment or under threat of it; in a chemical war environment or the threat of it. Requirements include night viewing goggles, protective overgarments and masks, rapidly erectable maintenance shelters.

* Immediate repair and resupply in whatever conditions prevail. Deferring repair and combat service support functions to a better time in a better location may not be possible because of the pace and the intensity of combat.

* Modular replacement made possible by design. It might be expedient to replace major modules even though a minor but time-consuming component repair would be more economical if time and the combat environment were not overriding considerations. Major modules would also simplify the supply and inventory problem.

* Throwaway design. War is wasteful. Processing equipment back into production line repair may be good economy in operating a truck fleet, but not in modern sustained combat. Combat vehicles, including trucks, might accommodate to component repair but only as a secondary condition and only where this does not subtract from modular replacement and the high-tempo actuality of the combat environment.

* Common modules, to the extent possible, in the entire family of vehicles. This would ease the problem of cannibalization from beyond-repair or beyond-immediate-repair vehicle carcasses in the battle area. These commonality considerations should apply not only to U.S. vehicles but throughout NATO. In concept development of modern combat and support vehicles it might be worth considering component convertibility with enemy equipment, that is, Soviet equipment. The Israelis have converted large numbers of captured Soviet equipment to operational use in their own combat forces.

* Triage decisions in the combat zone depends on the ready availability of a component or part. There is no time for manually filling out parts procurement requisition forms and usage or failure reports. It is well within the capability of microprocessor technology and computer-based management information and computer netting methodology to maintain a total inventory control in the most fluid and confused situations.

The NBC Continuous Land Battle

Nuclear weapons and other weapons of mass destruction -- chemical, biological -- do not reduce the importance of continuous combat but rather underscore the reason that this is likely to be the character of the next war. Unfortunately, according to the Chairman of the Joint Chiefs of Staff, General George S. Brown, the armies of the Warsaw Pact are the best equipped and trained for chemical, nuclear, and biological warfare. It is only recently that their doctrine admits the possibility that the war may be conventional or have a conventional phase. Indeed, the NBC battlefield is the primary reason for getting their soldiers inside the combat vehicle where the environment can be controlled while they fight from within.

Since the national attitude of allowing the enemy the first blow is not likely to change, it becomes all the more necessary to have an NBC war fighting capability in being -- immediately ready capabilities to meet mass destruction, continuous combat warfare; a credible capability for the actualities of NBC war, and not just a few spikes of high technology.

This means gaining an equivalent or superior NBC capability to that described in Soviet military writing and, more significantly, manifest in Soviet operational hardware.

These include:

* Protective overgarments, masks, chemical warfare antidotes and neutralizing agents, anti-radiation sickness pills in the hands of combat and support forces; and redundant protection as part of combat and combat support vehicle accessory equipment. Protective equipment should be designed specifically to minimize interference with sustained operating activities.

* Automatic CBR alarm systems.

* Complete mechanization of combat and combat support forces that will enable troops to fight from inside an armor protected high mobility box which can be sealed against NBC contaminants.

* A complete family of decontamination, sterilization, and washdown equipment, the doctrine for their use, and sufficient practice so that the equipment is assimilated into easy operational use.

* Medical support vans, armored and with the same environmental systems that will enable them to operate under high intensity, NBC battle conditions at the same pace as the combat units that they support.

* A complete family of chemical smokes, smoke weapons, and generators: variable density aerosol generators, screening smokes, opaque one-way smokes, protective anti-batericide and anti-chemical smokes, smokes for protection against nuclear weapons, smokes to create deception, confusion, and present the illusion of decoy forces, smoke capable of screening IR and even certain radar target acquisition devices. All combat vehicles and even combat support vehicles might be given an organic smoke capability.

Technology the Panacea?

Technology is looked on as an advantage held by the West where we can meet the Soviet nuclear, chemical, biological, and conventional continuous offense by a new, exquisitely brilliant technical device, that we can therefore reduce the numbers of men under arms and divert the budget to more pressing problems with safety, and that we are way ahead of the Soviets in technology. Somehow we must be disabused of these notions because not one is true. And worse, with the pace of the Soviet buildup and the projected rate of advance of a modern continuous offensive, there will not be time to put together an instant, high technology army. Soviet weapons have been tested against ours, we have had good opportunities to analyze them, and if they are not equivalent, then they are very nearly so. In the context of actual war fighting in a chemical, nuclear, and biological environment they are way ahead, and its doubtful that we will ever catch up unless we make a determined effort to do so. Most important, in military thought and organization to fight a modern continuous offensive war they are also way ahead. Leaning on technology somehow to restore the situation is leaning on a very weak and doubtful crutch.

There is also the matter of competition within NATO as opposed to cooperative and optimum use of an overall NATO military research and development budget. The problem is recognized and efforts are largely centered on committee action to reach agreement; a straightforward bureaucractic solution. What might be done is for the United States to provide leadership and example. A great deal of selfless action and yielding on pet projects would be required. However, it could be made to work and indeed it must be.

Finally, the long process -- some 20 years -- between developing a successful technology and its assimilation into easy use by the combat forces is not understood. Technologists can help circumvent this long integration period by working more closely with the operational forces. Even more important is advanced military doctrine based on a full awareness of the advantage that technology could yield. Most of all, there ought to be more evolution of technical equipment by operational units as is done by the Russians. Get the equipment out. This does not mean

test and evaluation by special squadrons or test organizations, because these quickly become just that -- special. The development needs to be done by the soldiers who will end up with the equipment.

Precision guided weapons -- antitank, air-to-ground, and ground-to-ground laser designated -- are not suited to the European environment or the battlefield tactics to defeat them that have been developed, tested, and described in tactical detail by the Soviets as far back as 1962. It may be that it is necessary to evolve a weapon from basic clear air mass and desert test range conditions progressively to the hostile and difficult environment of the battlefield, but that does not seem reasonable since the enemy has already laid out the environment and countermeasures in considerable detail. One-on-one PGM's are not likely to restore the situation. On the other hand, area weapons that, once released over the battlefield, are capable of homing on machines of war would have a high impact if they could be produced at reasonable cost.

We have leverage in the technical areas of microprocessors, small computers, and large-scale integration of solid state electronics. These are generally assumed applicable only to sophisticated, high cost weapons and systems. They might give us considerable advantage if they were applied imaginatively, not only to battlefield integration and management, an obvious application, but to training, crew selection, dynamic simulation within combat vehicles on training ranges and in field exercises, real time information at tactical level, forward maintenance and logistics concepts, high maintainability vehicles, physiological condition monitors, and cooperative transponders. The primary requirement is to identify high-impact pragmatic continuous combat applications. These devices can be rugged and cheap, well suited for the battlefield.

Additional Conclusions, Recommendations

* Important requirements essential for continuous combat operations are:

  1. The development of tactics, operational procedures, equipment, force organization and deployments for continuous operation. Modification of the TOE of combat units, combat support units, and service support units is one potential area of solution, but more basic changes are probably needed. (The Soviets document that less, not more, personnel are required.)

  2. Provide maneuver and support units the capability to operate day and night in an NBC environment for however long it might be necessary. [Marshal Savkin sets the schedule as 30 days; up to eight weeks]; to move rapidly regardless of obstacles, water barriers, minefields, contamination, or nuclear blowdown.

3. Provide commanders with the necessary means to command and control effectively under the stress of continuous operations. This requires continuity in the command function. The extreme fatigue of commanders and their decision level senior staff must be planned for.

4. Improve human endurance capabilities and design tactics, equipment and organization to enhance human endurance. (Unit replacement as practiced by the Soviets should be seriously considered.)

5. Detect, locate, and identify enemy combat units and the means to bring fire to bear quickly (the hand-off and BIFF problem).

* Fluid continuous operations will require constant surveillance of the battlefield in near real time. This will entail extensive use of advanced computers, data links and secure communications procedures and the integration of all sensor and intelligence gathering systems.

* In view of combat manpower advantages on the side of the Warsaw Pact forces and the relative simplicity and inflexibility of their tactics, the NATO forces could compensate with emphasis on research and development in quick response decision making at the upper command levels, improved communications systems throughout the forces, and flexible small unit tactics. An example of flexible small unit tactics that have great potential against armored thrusts are specially equipped air cavalry operations. Multiple penetrations by small battle units equipped with night vision equipment and portable armor-penetrating weapons could cause extensive disruption of logistics and echeloned forces. Should these air cavalry units be effective and painful, technology can be applied to create decoy forces to which the enemy would have to respond, a significant force multiplier advantage.

* The first priority is to counter enemy armor. Implicit in this is the development of aids to mobility, observation, and the destruction of armor at long ranges before the attacking forces become entangled in a direct fire battle. But not with clear air mass PGM's or one-on-one weapons which will not overcome the overwhelming numerical advantage that the Soviets have.

* In the rear areas it will be necessary to provide defense for logistic units, communications centers, headquarters, and air bases particularly against airborne and helicopter attack. Forces for this purpose must be highly mobile formations operating in conjunction with local forces.

* Effective fire support round-the-clock is a requisite to continous operations calling for all-weather fire support systems. Emphasis needs to be placed on aerial fire support both from the standpoint of interdiction and close air support. Close air and

direct fire support might best be done by RPV's controlled by the land combat commander, leaving interdiction to sophisticated aircraft that are capable of night and all-weather attack.

* In combat service support, transportation requirements will be increased requiring more rapid movement over greater distances. Greater dependence will be placed on air transport of material, ammunition, personnel, replacement parts, maintenance units, and POL. Advanced methods for packaging, refueling, and rearming as well as for the movement and control of materials are required.

* All of the above must be coupled with hard, tough training, not for night, but for continuous combat -- reverse cycle, day and night training for two weeks or more -- and not just combat units but service support and medical units as well.

* There is an accepted peacetime mode of operations, maintenance, and support, including medical, which it is expected will transition to a completely different wartime mode when it becomes necessary. But there won't be time to change to wartime organization, procedures, and methods of operations under the pressure and furious pace of modern continuous combat.

The Challenge

The Soviets document in operational and tactical detail the advantages of the continuous offensive. Their comprehensive body of military thought on continuous mechanized combat in the environment of the mass destruction battlefield is available to all who will read it. The hardware to do precisely what is projected in their doctrine is in the hands of their operational forces. The machines can be seen and counted and numbers grow more ominous every year.

There remains the question, do they have the capability to do what is said in their doctrine all backed up hardware in the field? If they can, then it is critical that we get this capability in the shortest time. If they cannot, then here is an opportunity to defeat numerically superior forces, equipped with technically equivalent weapons, by using our own forces intensively, without let-up, in continuous combat.

Wars are still won by men, not machines. Advanced military thinkers have always achieved the advantage over more conventional adversaries by imaginatively using the technology and weapons available to both.

CONTINUOUS LAND COMBAT

1. Introduction

This report presents the results of a study of continuous/2/ land combat operations. It was sponsored by the Tactical Technology Office of the Defense Advanced Research Projects Agency (ARPA)./3/ The task that was attempted, as assigned by ARPA, is stated below.

"The objective is to do an abbreviated comparison of current U.S. capability to conduct continuous land combat with the land and air forces needs to achieve such a capability. These needs are expected to cross established combat and combat support functions, such as close air support, logistics, and command and control. Current DoD developments focus only on improvements in range and resolution at lower levels of visibility. This analysis will take a systems viewpoint in order to pinpoint major steps needed to achieve a true capability: specially trained/equipped units; navigation; control; acquisition to move supply and maintain attack at night with major unit; psysiological and man-machine design changes to pace tension-relaxation over several day periods; vehicle-weapons designed for higher intensity use without normal maintenance; techniques for aircraft allocation and handover; seletive use of battlefield illumination with nightscopes; and IR and thermal image devices.

Warsaw Pact documents stress sustained combat, and the Pact exercises at it; however, our technology should permit the U.S. to truly have this capability once the full needs are recognized. The ARPA role through this task will be to identify these needs and pull together the disparate community to work toward achievement of this capability. Later, ARPA might undertake selective developments."

/2/ Continuous and sustained are used throughout the report somewhat interchangeably. In the semantic sense there may be nuances and shades of difference. What is meant, as it will be developed in this report, is the capability to wage modern warfare without let-up for those reasons that traditionally force a pause in combat activity -- night, fatigue, inability of logistics to keep up, and similar considerations.

/3/ The more familiar ARPA is also used interchangeably with the more precise DARPA.

2. Scope and Method of Approach

This task can be construed to be "as big as the world". However, a modest initial effort/4/ was allocated to several objectives:

* To make an abbreviated comparison of the status of the capability to conduct and support continuous land combat operations with what might be done to achieve that capability.

* To define the problem from the overall systems perspective and to gain some insight into its impact and implications.

* To learn what is the perception of the problem within those operational and technical orgnizations that are concerned with aspects of gaining the capability for continuous combat operations.

The method of approach taken was to first write a technical brief on this far reaching subject. This brief was based on technical reports and journal articles -- United States, NATO, Soviet, and Warsaw Pact. The briefing was presented to organizations most concerned with various aspects of continuous combat operations. A partial list includes:

. Armor Center and School, Fort Knox
. Army Aviation Center and School, Fort Rucker
. ARPA
. Combined Arms Center and the Command and General Staff School
. Defense Intelligence Agency
. Department of the Army
. Development and Readiness Command (DARCOM)
. Harry Diamond Laboratories
. The Kalergis Tank Forces Management Group
. Marine Corps Base Twentynine Palms
. Marine Corps Development Center, Quantico
. Night Vision Laboratory, Fort Belvoir
. RAND
. Tactical Air Command Headquarters
. Training and Doctrine Command

In addition, there was a great deal of technical discussion and correspondence with knowledgeable professionals.

There are many organizations with equal concern and responsibility for continuous land combat -- logistics, infantry, human factors -- that do not appear on the list. This was not an oversight or a matter of priority. It was a limitation of time and level of effort. There is much more that should be done.

The brief was for the purpose of establishing the basis for technical discussions. What was learned is the primary basis for the material presented in this report. An effort was also made to establish a point

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/4/ One analyst; one year.

of contact for continuous land combat technical and operational matters "to pull together the disparate community" so that an interchange of information could be effected. Every organization cooperated by assigning a point of contact. However, correspondence that posed questions and attempted interchange of points of view, did not produce much response. The concept of information interchange and "points of contact" is sound. However, it is perhaps the case that there was insufficient opportunity for follow-up, a limitation of the effort that could be put on this aspect of the work.

The information and material derived from the technical discussions and the correspondence was augmented by a study of the literature on the many ramifications of the continuous land combat problem. Classified and unclassified sources were used. What is contained in this report is based primarily on unclassified sources and the report has been kept at that level. The unclassified material available is comprehensive, adequate, and authoritive.

The words "land combat" appears in the task and the title. In no sense is this intended to exclude air support of continuous combat. Air operations -- transport inter and intra theater, helicopter operations, reconnaissance and target acquisition, interdiction -- are very much an essential part of the capability for continuous land combat. What may appear to be a lack of emphasis should not suggest an ordering of estimated importance by content presented. It is simply that the impact, implications, and ramifications of sustained combat are so enormous and far-reaching and will have such a fundamental impact on organization, doctrine, command, training, equipment, and research, that it is not possible to adequately cover any of the elements of the problem completely. In every sense it is a combined arms problem where continuity in combat service support and logistics is as essential as night capable mechanized forces.

The subject is controversial and there is a lack of agreement on continuous land combat, or even that there is such a problem. The ARPA objective in tasking the study was to present the problem to a wide range of organizations in order to stimulate thinking and interest in what might well be today's advanced concept of modern combat as was the "blitzkreig" formulated and practiced by by Guderian/5/, Rommel, and von Monteufel more than 30 years ago.

The technical and operational response as to the status and importance of the problem and to the material, ideas, concepts, conclusions and recommendations presented in this report can be useful to ARPA in planning its advanced research program. There is no lack of important problems that merit research support and from which useful improvements in capability would result. The very difficult problem is what to support within a limited budget that will have the maximum impact. Is the capability for continuous combat operations vital? If it is, what are the key or fulcrum reserch areas that ARPA could address that would best

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/5/ Guderian's 1937 writings on armored "blitzkreig" tactics drew heavily and with admiration from the work of General Chaffee.

achieve the capability for continuous operations within the combat forces of the United States.

What follows is a brief discussion of what is meant by continuous land combat operations, a statement of Soviet perceptions, some limited historical precedents, and then a section on the implications of continuous land combat. These implications cover almost every aspect of land combat and the support of land combat. Then selected important implications, such as doctrine, night combat, air support, are presented in the sections that follow. In each of these sections the attempt is made to close in on the important problems, to suggest what might be done, and to propose some ideas and technical concepts that merit consideration. The conclusions and recommendations section contains a summary.

This work is not intended as a threat or net assessment document although Soviet military writings were extensively used. Encyclopaedic lists of materials, equipment and characteristics or numbers of NATO and Warsaw Pact tanks, organizations, and men under arms are also not included. This kind of information might form a useful appendix but it is readily available to the interested reader from many sources.

3. Continuous Land Combat Operations

Whenever this subject has been studied, a definition for what is meant by continuous combat in terms of specific time limits is always sought such as up to three days, day and night without letup; or five days; or some bounding condition. For example, a recent study was tasked by DDR&E to determine the technical competence of the U.S. and U.S.S.R. to sustain combat day and night for a five to six-day period regardless of the weather./6/ The Institute of Advanced Studies was directed by the Department of the Army to consider "the application of combat power at about the same level of efficiency throughout a 24-hour period for periods which may extend up to 30 days./7/

Using the Warsaw Pact threat as the sizing force to gain some insight on "how long is continuous," Siderenko has this to say in his respected treatise, "The Offensive,",/8/ "The offensive ... will be conducted night and day, in any weather, without let up until the enemy is defeated."

In Savkin's "Operational Art and Tactics", he sets a schedule as follows, "Recognizing the important significance (to the attacker) of high tempos of advance for disrupting the mobilization measures of NATO countries, foreign military authors express the following thought: NATO can create the forces sufficient to delay an attacker only one month after the beginning of mobilization." According to the evidence of F.O. Mikshe, "Considerable reinforcements from the USA will be able to be committed to action in Europe no earlier than after an eight-week period. In spite of all the successes of technology, only a comparatively small number of light forces can be moved across the Atlantic by air. Thus, high tempos of attack may lead to a disruption of the mobilization, deployment of the enemy army, of the massing of the forces necessary for a successful defense, and of reinforcements from another continent."/9/

Summary: Continuous equals 30 days; up to eight weeks; until the enemy is defeated.

There have been few historical examples of modern continuous land combat operations from which to learn: General Patton's forced march

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/6/ "Net Technical Assessment of U.S. and U.S.S.R. Capabilities to Conduct Continuous Combat Operations During Periods of Restricted Visibility, (U)", C. J. Lowman, others, Systems Planning Corporation, Report No. 237, October 31, 1975, SECRET.

/7/ "Army 85 Concept Follow-on Studies (U)", U.S. Army Combat Developments Command, Institute of Advanced Studies, Carlisle Barracks, Pennsylvania, "Continuous Operations (V)", (ACN 13523), April 1969, SECRET.

/8/ The Offensive (A Soviet View)", A.A. Siderenko, Moscow, 1970, translated and published by the U.S. Air Force, Government Printing Office, Cat. No. D301.79:1 p.vii.

/9/ "The Basic Principles of Operational Air and Tactics", V. Ye Savkin, Moscow, 1971, p. 173, U.S. Government Printing Office, Cat. No. D301.79.4.

which culminated in the relief of the 101st Airborne Division at Bostogne, General Heinz Guderian's XIX Panzer Corps' drive to the channel parts in May 1940, the Soviet Army's Operation Bagration in the Belorussian campaign in the final phase of the Great Patriotic war, had drives which were sustained and required enormous planning and support that a major continuous attack into Europe would demand today.

Guderian perhaps best understood the advantages that could accrue to a modern mechanized combat force by continuing a successful attack and breakthrough without let up. His military writings on the subject in 1937 are echoed in the Soviet Military Thought series. ("The Offensive", Siderenko; "Operational Art and Tactics", Savkin, others.)

He implemented his concept in the attack across the Meuse on May 13, 1940 at 1630 hours until the channel ports were reached by the XIX Panzer Army Corps on 26 May and the enemy defeated. Once he broke through, he pressed on day and night not allowing his enemy to recover or regroup.

The advantage of pursuit has not been lost on the Soviets and is the entire reason for their emphasis on sustained operations. Their study of their own experience in the Belorussian campaign has convinced them that, once their dues are paid in the losses necessary to break through, their overall casualties will be much less and every advantage comes their way if they do not allow obstacles or water crossings to force a pause and pressure is kept on the enemy so that he cannot reorganize or regroup. The extraordinary pay-off more than makes up for the considerable effort required to gain the capability for sustained operations. They also document that fewer personnel are required in the combat division although its mechanization and lethality are much higher.

This perception of the advantages of continuous land combat is in contrast to the NATO Alliance countries. A comprehensive and authoritative report on limited visibility combat written by a large panel of NATO military and civilian professionals concluded that, "...NATO as a whole, as well as the individual national NATO armies, have not fully grasped the significance and implications of the 24-hour battle. Lip service is being paid to equipment, tactics and training from this most vital standpoint..." And also, "...Evidence points to the fact that potential enemies have appreciated this fact and are fully exploiting the possibilities, particularly as it is a known weakness of NATO forces..."/10/

The Army 85 Concept Study, done by the U.S. Army Institute of Advanced Studies, addressed "Continuous Operations"/11/, concluding that it was a relatively unexplored area. "[There are] many current studies and material development on various facets of night operations but none

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/10/ "Study on Fighting Under Conditions of Limited Visibility", Long Term Scientific Studies, Defense Research Group, AC/243-D/143, AC/243 (Panel 1) D/26, October 1971, and Addendum 8 May 1972, NATO CONFIDENTIAL.

/11/ "Army 85 Concept Study", Prepared by the Institute of Advanced Studies, Carlisle Barracks, Pennsylvania, December 1966, SECRET.

deals with continuous operations. The best effort is RCA's 1963 study, 'Conquest of Darkness'".[12]

Briefly, the Soviets have documented "how-to-fight" doctrine predicated on continuous intense operations centered around tank heavy, completely mechanized forces. It has been well thought out, in such detail as to suggest that they got their "hands dirty" trying it out. Their military build-up is beyond anything needed for defense, and is clearly configured for high tempo blitzkrieg operations, whether the war be conventional, nuclear, chemical, or biological. They are fully night equipped and have bridging and obstacle crossing equipment that has no equal. All this so that the war will be short and done before a nuclear decision is made, NATO mobilization is disrupted, and reinforcements in strength cannot arrive on time. At policy level, the growth of this ultra blitzkrieg capability has been watched. Continuous combat, the main precept of modern combat according to the Soviet doctrine, has been termed the "24-hour battle" requiring only the capability to fight at night, an over-simplification. The job given to the combat forces is to meet this threat through innovation, imagination, tough training, using high technology, a low budget, and the will to win.

/12/ "The Conquest of Darkness", F. P. Henderson, D. S. Bond, RCA Advanced Military Systems, Princeton, New Jersey, July 1963 (AD 346297). This is a well documented reference and some of the material on which this concept paper is based is presented in this excellent report. It deals primarily with the operational use of scotoscopes but the supporting material on night and continuous operations is very perceptive.

4. U.S. Perception of Continuous Combat and Status of Capability

There is very little doubt that the civil and military leadership in the United States has perceived the threat of intense, high mobility combat, day and night without let-up, that has been developed in fine grained tactical detail in Soviet military writings. Marshal Malinovskiy, former Soviet Defense Minister, presents a reasonable explanation of why it has been discussed openly: "The best method of defense is to warn the enemy of our strength and readiness to smash him ... This is why we do not hide our points of view on the nature of future war and the means of conducting it but present them in this work, "Military Strategy" (p. xxvii)/13/. Another important message, in that same book, states "the cardinal sin in military leadership is to fail to recognize the nature of your probable opponent." (p. xv). It is a very important point and the theme of this report.

The Soviet doctrine of continuous operations and the intent to sustain the offensive "day and night, in any weather, until victory is achieved" has, of course, been viewed with serious concern. The Soviet conventional and nuclear build-up is beyond any scale or configuration that could be even remotely considered for defensive purposes. Their tanks, motorized military combat vehicles and river crossing equipment, all night capable, presents solid evidence that they have the tools to implement what they say in their military writings.

Secretary of the Army Hoffman stated his concern this way: "In the past we have taken some comfort in the large qualitative advantage that we possessed. But the Soviet weapons have been tested against ours and we know that the qualitative advantage has been drastically altered to our disadvantage. We must be prepared to fight round the clock, 24 hours a day, in any weather ... Readiness is developed and then reinforced by tough, demanding realistic training ... Superior equipment cannot make up for lack of knowledge, or the will to win."/14/

In this statement there is at the same time the problem definition, an easy misconception, and a solution. The Soviet's enormous build-up is clear to all. Their concept and doctrine of continuous combat is documented and well thought out. The problem, however, has been construed as the 24-hour battle where night capability would, of course, be essential, but the intense combat would have to be of limited duration, a misconception. If this were so then no fundamental changes in doctrine, tactics, or support organization and procedures are necessary, the gut issue. The solution is in knowledge, training, superior equipment, and the will to win.

In amplification of the statement of the problem and to underscore the importance of understanding the impact of sustained combat, Under Secretary of the Army, Norman Augustine, had this to say, "The days of

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/13/ Soviet Military Strategy", Third Edition. Originally published 1968, Voyennaya Strategiya, Voyenizdat. Published in the United States by Crane, Russak and Company, Inc.

/14/ Army Research and Development News Magazine, November-December 1975, p. 40.

slogging, multicampaign wars in Europe are very likely over. Bond drives, gearing up, mobilization and the type of determined national production effort which defeated the Axis in World War II could potentially be as irrelevant in a future war as the barrage balloon or the carrier pigeon. The demand, increasingly placed on our forces today, is to win the first battle -- not simply the last one ... The ominous datum ... is that the USSR is in many respects better equipped than we to withstand a compressed attritive war."/15/

"The destructiveness and intensity of modern warfare is visible in vivid microcosm, even today, in the Mitla Pass between Egypt and Isreal. The terrain is littered with the rusting hulks of armored vehicles destroyed in one of the most violent and cataclysmic clashes, for its scope, in modern history. Syria and Egypt alone managed in 19 days to lose more tanks and artillery pieces than the United States owns in Europe ... Ominously for the West, it is altogether likely, even probable, that the same transborder, blitzkreig tactics which were so devastating in the Middle East will be employed in the event of a clash between the Warsaw Pact forces and NATO."/16/

The importance of the first battle has found itself as the keynote in the new Army Doctrine manual FM100-5: "Today the U.S. Army must above all else, prepare to win the first battle of the next war." It also recognizes that "Forward deployed forces, and those reinforcements immediately available, must be prepared to accomplish their mission [win the first battle] with the resources in hand. They must anticipate combat against forces with ultra-modern weapons, greater numbers, and nearby supply sources."

Drew Middleton in his book, "Can America Win the Next War" has made a very good analysis supported by many documented interviews with military and political leaders in Europe. He agrees with the statement of the problem presented by Secretaries Hoffman and Augustine and the new Army doctrine. He also suggests that the Seventh Army, "the most powerful force in Europe" may find itself out of position because the main tank heavy Warsaw Pact thrust would most likely come across the northern plains. The main line of communications supporting the Seventh Army from the seaport of Bremerhaven could be cut in one day. REFORGER units, about 15,000 strong could be flown across quickly but this number is insignificant. Reinforcements in any strength would have to come by sea and would take 50 days, perhaps eight weeks./17/

There is not universal agreement on what has become known as the "importance of the first battle," or the "short vs. long war"; on continuous operations as opposed to diurnal highs and lows and spasms of intense action interrupted by rest and regrouping. However, R. W. Komer

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/15/ "New Technology for an Army of Opportunity", Hon. Norman. R. Augustine, Under Secretary of the Army, National Defense, November-December 1975.

/16/ Op. cit.

/17/ The Soviet's agree with Middleton. See Savkin, "The Basic Principle of Art and Tactics", Moscow, 1972, p. 157. Previously cited.

brought the matter into sharp focus when he wrote: "There is too much sloppy thinking about 'short war' versus 'long war' concepts with doctrinal, if not theological overtones, which obscure rather than clarify. This is not an 'either or' proposition, but rather how much relative effort should be put into early deterrence defense versus hedging for a longer conflict ... One may not be able to win a NATO-Warsaw Pact conventional clash in Europe in the first 30 or 40 days, but one could certainly lose it -- which would make capabilities to fight a longer war in Europe rather academic." /18/

To put all the above together, there is abundant recognition at policy making level that the Warsaw Pact forces are structured for an armor heavy blitzkreig, that they (the Soviets) must win before mobilization and reinforcement can take place (30 days to eight weeks). To do this they must mount an offensive day and night, without let up, in any weather, and have combat and logistic support organized and structured to sustain these operations. This threat cannot be resisted by the procedures, doctrine, and organization of the last war which is essentially the situation in NATO if nuclear weapons are not introduced.

Doctrinal and policy statements have been written that emphasize the importance of winning the first battle, of fighting outnumbered, and about the importance of night combat. Yet, the matter of how to fight a war beyond what could be demanded from the forces in position at the point of combat contact has not really been addressed. This is the essential first step: The thinking out of the problem. It has not been done. In fact, because of the potentially very significant changes that would be required in organization, training, doctrine, and equipment, coming to grips with the continuous land combat problem has been resisted with the justification that the Soviets do not have this capability anyway. Doctrine and equipment, yes, but they do not train enough particularly in large scale field exercises at night. And that is where matters stand./19/

The subject of continuous combat has had modest support within ARPA; virtually none in the Army, Marine Corps, and Air Force. But unless this is gotten in hand, everything else will be after the fact or will force an intercontinental strategic nuclear war. Almost all major efforts have to do with nuclear weapons, strategic warning systems, sorting out underwater sound, ASW programs, and the physics of sub-systems (sensor technology and the like). These may be academic exercises if research, technology and military thinking cannot meet the Soviet blueprint for reaching the channel ports in a continuous, sustained drive.

/18/ "Shedding the 'Short vs. Long' War Theory," R. W. Komer, Army, February 1976.

/19/ Based on technical discussions in the course of the study.

5. The Impact of Continuous Land Combat Operations

The implications of what is required for continuous combat operations are enormous. The very nature of land combat and the support of land combat is affected and not simply as an added consideration but as fundamental and far-reaching changes in organization, equipment, tactics, doctrine, training, and manning requirements. This may explain why a limit is always sought when this problem is addressed and sized or bounded. Intense day and night combat for a limited period might be achieved by extraordinary effort stretching human capacity to the limits until both sides are exhausted and their equipment in shambles. If the requirement to gain a sustained land combat capability were no more then this then present doctrine, organization, and equipment could be made to do with increased emphasis on night and restricted visibility operations, precisely where matters stand today. However, this is not the kind of combat that advanced thinkers like Guderian perceived or what the Soviets learned from the Great Patriotic War.

The matter goes beyond the fielding of technological systems, although these are essential and indeed are the fundamental reasons why night and sustained combat will become a reality even if the Soviet threat were not the forcing function: When it can be done, it will be done. There have always been those advanced thinkers who, by imaginatively using the same technology and weapons, as their adversary have gained enormous advantage./20/ Malcolm R. Currie, Director of the Department of Defense Research and Engineering, said: "I don't think that we will be surprised by the appearance of unforeseen new weapons or reovlutionary technology ... but we may well be surprised by the innovative use of a technology which can be decisive. History provides examples of advantage through superior understanding of the significance and impact of new technologies. The German employment of tanks against the French and the British in 1940 is one such example. Germans understood the potential of armored units used offensively in the battlefield environment and from this understanding devised combined arms tactics which are devastatingly successful and which are still being copied./21/

Fundamental to continuous combat operations are psychological and human factors considerations. Machines can be made to operate continuously; men cannot. Individual and unit training are essential to turning fear and strangeness of night combat, which are exagerated by fatigue and the stress of sustained combat, into an advantage. The rotation or echelonment/22/ of forces is necessary so that fresh troops are cycled to the point of battle contact. Essential combat, combat support, and command and control must operate continuously. Logistics are affected

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/20/ The report, "Historical Trends Related to Weapon Lethality", Historical Evaluation and Research Organization, Washington, D.C., 15 October 1964, UNCLASSIFIED (DDC 458 760) illustrates this important point with many examples. "it has always been new ideas which permitted inferior military forces to overcome forces that were larger and/or better equipped." (p. 38).

/21/ Aviation Week and Space Technology, May 24, 1976. Text of Currie's speech before the ADPA Joint Tactical Missile Conference.

/22/ Soviet doctrine; there is no U.S. or NATO counterpart.

not only in volume but in class of materials. There are many other dimensions to the problem.

The tempo of operations will increase. There will be less time available to reach decisions. This will require changes in present doctrine for the organizational and logistic planning of an operation, the organization of the forces to be used, and the conduct of the battle.

Fuller understanding of the nature of combat under continuous operations will be necessary for the development of doctrine relating to the purpose, composition, and use of reserves. In an extended high tempo continuous operation, the regular relief of companies, battalions, and brigades must be provided for in the commander's plans. There might be a deliberate effort to shorten the duration of a continuous combat operation by committing most of the force with little held in reserve. Or an enemy capable of unremitting attack, organized to echelon fresh combat units to maintain momentum, may force the commitment of the reserve forces.

A continuous combat capability must be accompanied by continuous logistic support capability. Present logistic operating concepts and planning factors have been established to conform to the requirements and environment of a day-night daily operational cycle. The daily consumption rate of supplies will increase. However, the fact that a force may accomplish its mission in a shorter time may reduce the total amount of supplies required. Daily consumption rates of rations and water (Class 1 supplies) will increase. New concepts for feeding troops and support units may be necessary. Concentrated high energy foods and endurance prolonging drugs may be added to the ration.

Whether ammunition consumption will increase by any significant amount is not so certain. Large amounts of small caliber ammunition are now fired in night combat actions, especially by the defense. Much of this is blind firing.

Continuous day and night operations will increase the maintenance requirements of a force. The intensified use of vehicles and weapons will accelerate wear and breakdowns. Since the overall duration of the campaign should be short, established maintenance and repair activities as well as equipment and supplies might be reduced or eliminated.

Continuous combat and supporting operations will establish new performance requirements for participating units. Present unit TO&E's, which have been based on long experience in noncontinuous operations will have to be changed to provide the capabilities called for by a new mode of warfare.

Success in modern land warfare is increasingly dependent upon an ever growing number and variety of machines. These are ideally suited for the conduct of continuous operations so long as their needs for operating supplies, maintenance, and operators or crews are met. It can be noted that those forms of warfare that are presently the most highly mechanized -- naval warfare, air defense warfare, strategic air warfare -- are characterized by a continuous operating capability. In modern

mechanized armies there will be comparable machines in opposing forces. The opponent who achieves the most efficient sustained utilization of his machines will have gained a distinct combat advantage.

Continuous combat operations will place extreme demands on commanders and their staffs. The traditional pattern -- conduct and supervision by day, planning and evaluation by night -- will not be adequate for the needs of forces engaged in continuous operations. The increased tempo can lead to rapidly changing combat making it more difficult to keep aware of the battle situation and to control the combat and support units that are assigned./23/

Human fatigue is an obvious limiting factor and a great deal of research has been directed to this aspect of combat. Some limits have been sought. The Army 85 study suggests planning a 24-hour duty cycle in continuous combat operations. While no specific duty cycle has been established under the Soviet doctrine of the echelonment of forces, a forward unit in combat can look forward to being relieved by a succeeding unit. It will not be an orderly 24/24 hour pattern of duty but will depend on the combat situation. However, except for disaster, the fighting force can look forward to being relieved by the following echelon.

The important point that must be recognized when combat fatigue is being considered is that the effects pyramid rapidly both in victory and defeat. In his orders to the troops after their victorious drive to the channel Guderian stated, "I asked you to go without sleep 48 hours, you have gone 17 days." Clearly, no human being can go 17 days without sleep. But these were the same troops that were called upon to continue day and night for 17 days of fighting and fighting very effectively whenever resistance was met/24/, catching short naps when they could. Yet they were still a very effective fighting force when they reached the channel. They achieved victory after victory, gained great confidence in their leaders, and, while they had to be very fatigued, their success sustained them in a remarkable way that does not have a parallel in civil activity or even in training and field experiments.

The opposite pyramiding effect in defeat was observed by N. C. Meir in his 1943 work, "Military Psychology": "The Dunkirk evacuation left many participants with physical effects marked by thinness of face, pallor or sallowness of complexion, and considerable loss of weight. Many were tense and some were apathetic; sleeplessness and terrifying dreams of battle were common experiences. Stuporous reactions characterized

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/23/ "Conquest of Darkness", F. P. Henderson, previously cited.

/24/ This was no "piece of cake." The XIX Army Corps "... thrust through the Belgian fortifications, forced a passage of the Meuse, broke the Maginot line in the Battle of Sedan, captured the important heights at Stonne, and then, without halt, fought their way through St. Quentin and Peronne to the lower Somme at Amiens and Abbeville. Then set the crown on their achievements by the capture of the Channel coast and the Sea fortresses at Boulogne and Calais", (from Guderian's May 26 order of the day).

some of the men before evacuation."/25/ These were the defeated in the same campaign, the same theater of operations, with essentially the same equipment. In fact, the troops at Dunkirk probably had less physical exertion and endurance demands made of them than the troops of Guderian.

/25/ "Continuous Combat Operations," Maj. Harold L. Shortnacy, Infantry, January - February 1973.

6. Night/Continuous Combat

6.1. Introduction

Continuous combat operations are dependent on the capability to fight effectively at night and to carry out those functions that are essential to combat support at night as well. There is agreement on this. This section presents an estimate of the status of the capability of U.S. land combat forces to conduct night operations and to sustain an intense level of combat on the modern battlefield without pause or let-up, a much broader and more difficult capability to achieve.

The material presented is drawn largely from a U.S. Army Training and Doctrine Command (TRADOC) initiated study on the status of the Army's night operations capability and goals that was conducted by the Combined Arms Combat Development Activity (CACDA); the proceedings of a night operations conference convened in July 1975 to review night operations doctrine, material and training throughout the Army/26/; the concept paper on night operations/27/ produced from the study; and on a recent analysis of the impact of night observation and detection devices.

6.2. Combat Experience in Night Fighting

In World War II the movement of troops at night was commonplace, although American, British, and German forces rarely attacked at night. Extensive road networks and the heavy use of motor vehicles in Europe permitted the movement of tactical formations at night. Nighttime resupply operations by both sides were routine.

The Germans made extensive use of night movement in their blitzkrieg operations early in the war. Night movement over good road nets contributed to the rapid German advances through France and the Low Countries in 1974. German infantry and tank units moved through gaps, disregarded firing and fighting on their flanks, and drove behind the enemy front at night. By daybreak they were deep in the Allied rear, often having covered 50 to 100 kilometers.

In 1941-1942 the Germans continued to operate at night on the Russian Front but with less success because of the poor road network and the use of darkness by the Russians. Russian forces habitually used the night for movement. Russian partisans used the night to attack supply routes and depots deep in the German rear.

After the Allied invasion of Europe in 1944, German commanders expected large-scale night attacks. They feared that Allied mechanized forces would use the night to breach the West Wall and close on the Rhine River. However, the Allies made relatively little use of darkness, and large-scale night offensives did not take place. German authorities

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/26/ "Night Operations Conference, 29-31 July 1975", Memorandum for Participants, ATSW-TA-1, Combined Arms Center and Fort Leavenworth, October, 1975.

/27/ "Concept Paper on Night Operations", ACN:22722; United States Army Combined Arms Center, Fort Leavenworth, Kansas; August 1975.

attributed this to an Allied reluctance to accept the hazards inherent in night combat in view of the massive air power they had available which could support only daylight operations./28/

The most prominent exception to the apparent reluctance of U.S. units to engage in night combat was the U.S. 104th Infantry Division. In less than six months during the winter of 1944-1945, the division made over 100 night attacks, with notable success./29/

Despite few exceptions, the daylight cycle was so much a part of the routine of U.S. units in Europe that notes on battle experiences published in late 1944 said that attacks should stop at least an hour before dark to permit setting up adequate defenses against the German counterattacks expected after dark./30/ The notes also mention that German prisoners reported being able to rely on the fact that "Americans never attack at night."/31/

Extensive night combat, mainly defensive, was forced upon U.S. forces in the Korean War. This occurred because the North Korean and Chinese enemy habitually attacked at night to avoid U.S. firepower and air superiority. When the war became static, both sides dug into elaborate positions backed up by massive firepower. Extensive night patrolling was practiced by both sides, but U.S. units mounted few night attacks.

U.S. forces used artificial illumination more in this war than in any previous war. All-night illumination of a regimental front with artillery flares and searchlights was commonplace; many U.S. commanders believed that "turning night into day" was a great help to the American soldier. Nevertheless, the North Korean and Chinese Communist forces were able to make effective use of the night. Even under illumination, their attacks were often not detected before they had advanced to within hand-grenade range.

In Vietnam, large quantities of specialized electronic night fighting equipment were used for the first time in warfare. However, they made little contribution to the effectiveness of U.S. and South Vietnamese forces in night combat.

The radar sets were (and are) heavy, bulky, and difficult to deploy. Despite being set up in locations carefully selected to avoid terrain masking, they proved to be unreliable in detecting enemy forces and

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/28/ (U) U.S. Army, Office of the Chief of Military History, "Operations in Darkness and Smoke (U)", by Guenther Blumentritt, MS B-683, originally prepared by Historical Division, European Command, Foreign Military Studies Branch (Washington, 1952), Unclassifed.
/29/ "Night Operations; A Report on Night Operations As Executed by the 104th (Timberwolf) Infantry Division," Military Review (U), December 1945-January 1946, p. 55, Unclassified.
/30/ U.S. Army War College, Ground Forces, [Battle Experiences, Twelfth Army Group] (U), No. 5 (Washington, 15 November 1944), p. 1, Unclassified.
/31/ Ibid., No. 22, p. 4.

were difficult to maintain. There was no evidence that they detected a major attack on a U.S. position. During the sporadic heavy fighting in northern I Corps in 1969-1970, the U.S. 101st Airborne Division employed 30 ground surveillance sets. Most were set up on major firebases. One brigade deployed them with small security forces throughout its area. Seven major attacks were made by the North Vietnamese on firebases that had the radar sets and not a single attack was detected by radar. Other divisions had similar experience.

On the other hand, radar-using units experienced high rates of false detection and after months of deploying forces to check out these detections without achieving enemy contact confidence in the radars was undermined to the extent that the units would not voluntarily employ radars at all.

Though starlight scopes functioned reliably and were easy to maintain, most soldiers avoided them after trying them out. The reasons include: (1) physical discomfort and interference with vision and hearing associated with their use, (2) difficulty of searching a broad area with a device having a narrow field of view, (3) problems of zeroing, and (4) the frequent availability of enough light in a firefight to make a night sight unnecessary.

The bright-green background of the image tube and the strain of prolonged peering into it caused eye fatigue and headaches in soldiers who used the starlight scope for more than 15-20 minutes. Their eyes were also strained by the pulsing of the image background during a firefight, when flares would momentarily raise the ambient light level. More serious, the scope also blocked peripheral vision, and the bright background destroyed dark-adapted vision in the soldier's scope-viewing eye for at least 15 minutes after each use. Soldiers did not want to risk being caught partially night-blind when a fire-fight broke out. Largely for that reason, patrols and scouts for attacks and infiltrations rarely used the starlight scope.

Many soldiers felt that using the starlight scope made them more vulnerable to discovery by the enemy. When the user removed his eye from the scope, light from the eyepiece reflected off his face. The device also emitted a slight static hum. The hum, moreover, interfered with the user's hearing, an even more important sense in dark than in daylight./32/

Soldiers using the crew-served weapon sight and the night observation device had the same kinds of physical discomforts experienced with starlight scopes. Because of their weight and size, these devices rarely accompanied moving units.

Attempts were made to use the night observation device to adjust artillery fire. Even when the device located a target, it was almost impossible to relate the target's image to its actual location due to the

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/32/ Discussions with Night Vision Laboratory personnel indicate that many of the shortcomings have been overcome in the improved equipment becoming available.

narrow field of view and the difficulty of estimating range in a telescopic viewer. As a result, unaided vision was generally more successful in night adjustment of indirect fire.

A survey of experienced U.S. combat commanders that was made by Stanford Research Institute/33/ revealed that night and adverse weather combat is not considered to be a strong capability of U.S. forces. The respondents preferred not to conduct in-depth attacks, air mobile operations, or attacks on prepared defenses. Operations preferred at night were limited objective attacks, river crossings, withdrawal, relief, and patrol or ambushes. It was made clear, however, that even limited objective attacks reflected a rare willingness rather than a true preference. The reason was best summarized by the statement: "Almost always in WWII, Korea, and VN we had superior firepower and its effectiveness was in direct proportion to visibility. Where fire support is definitely ours, it is just plain foolhardy to forsake it in the hope of achieving surprise in night attack."

The ability to fight at night has always been an important military asset. Forces that are culturally limited to and intensively trained for night combat have realized significant advantages by fighting at night. Despite doctrinal pronouncements, U.S. forces rarely engaged in night combat and then usually by some elite or specially trained units which achieved extraordinary success. U.S. forces have not found it necessary to exploit night combat operations because they usually had an enormous fire power and air support advantage. The air power, fire support, mechanized equipment, and technology advantage may not be there should the war be against the Warsaw Pact forces in Europe. It will then be necessary to fight when the enemy chooses, where he attacks, and for as long as he forces the combat offensive.

6.3. The Army's Goal in Night Operations

The Army's goal in night operations is to attain the capability for using terrain and weapons in night operations with effectiveness comparable to that attained in daylight operations. This applies to combat maneuver units, combat support and combat service support units.

This was the goal established by TRADOC and presented as guidance to the CACDA study team. It sets day combat as the "norm" against which to work.

Why shouldn't land combat at night have an entirely different character and much greater effectiveness because of the technological systems that make combat at night possible? For example, the limit of visibility of a man's eyes is puny compared with radar, or thermal imaging, particularly where the problem is to detect military machines and objects at a distance or camouflaged. Modern combat is machine dependent. While not nearly so versatile as a man on foot for certain situations, the men inside machines can control their environment, are in a hard

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/33/ R. W. Millican, W. F. Hardman, "Restricted Visibility Land Combat Questionnaire Survey," Stanford Research Institute, Research Memorandum 192-2-1, January 1973, UNCLASSIFIED.

shell, can travel (terrain permitting) orders of magnitude faster, and can "see", navigate, communicate, and use more powerful weapons than any man or men can carry. As land combat becomes more lethal and machine dependent, its character can be expected to change as has other forms of combat historically more machine dependent. Naval ships, for example, are fought by men in darkened red-lighted rooms. They use the same kind of sensors and video displays as are being developed for modern land combat vehicles and associated land combat command and control facilities.

It is suggested that day and night land combat will become more mechanized and technology dependent, that the character of combat will become nearly the same, but the normal will be night, not day, and that it will be more lethal and much more far ranging in the context of target acquisition, weapon delivery and spatial considerations. The trend is in that direction and other machine dependent modes of combat have provided illustrative precedents.

6.4. Continuous Operations, Army Status

"A continuous operation involves the continuous employment of Army forces, and the application of combat power at about the same level of efficiency throughout a 24-hour period, and for an extended span of time. Although a capability to conduct night operations effectively is essential before continuous operations can become a part of Army doctrine, the two types of operations -- night and continuous -- should not be confused. Once the Army's goal for night operations is achieved, the ability to efficiently conduct continuous operations will become more of a reality."/34/

"A capability to conduct continuous operations includes not only a capability to conduct operations on a 24-hour basis for prolonged periods with comparable efficiency; but, also, it includes a capability to initiate or conduct operations regardless of duration, at any time during a 24-hour period. Both capabilities will contribute significantly to a commander's operational flexibility and must be considered in determining the operational implications of continuous operations. The necessity for U.S. forces to conduct such operations is dictated by the existing Soviet doctrine and capability to carry out continuous operations."/35/

"The Army's goal must be reflected in doctrine, material development and training for night operations, and ultimately for continuous operations. At some point, after the present goal is attained, we must then maintain and continue to improve our capability for using terrain and weapons in night operations with effectiveness comparable to that attained in daylight operations. This, too, is supplied in the stated goal, and is a pre-requisite for conducting continuous operations."/36/

/34/ Institute of Advanced Studies, (S) "Continuous Operations (U)," Carlysle Barracks, Pennsylvania, 4 March 1968, pp. 5-6.
/35/ Ibid, p. 7.
/36/ Ibid.

These statements and recommendations from the CACDA concept paper are very sound but may contain an easy way to postpone taking on the very difficult problems implicit in continuous operations that were touched on in the previous section: major and fundamental changes in organization, TOE, crew relief, command, logistics, maintenance and combat support at a high intensity pace without pause or let-up.

The goal of continuous operations must be stated in Army doctrine as the basis for material development and organizational planning before any concerted effort can be made. However, if the goal is "first night then continuous" the Army's goal will be implemented in programs, material development, and training directed toward the capability to fight at night. When this happens the real issues are avoided and all can be kept busy at matters having to do with night combat.

The capability to fight effectively at night will never be reached as a definable benchmark to look back on so that the next goal of continuous combat operations can then be established. Another important consideration is that there are many very important problems across the board -- doctrine, planning, training, material, research -- that are essential to continuous operations which have little to do specifically with night. So concentration on night will dilute the effort and delay gaining the capability for continuous operations.

A faculty bulletin of the Army's Command and General Staff School had this to say about the importance of night/continuous combat:

> "First, we recognize that our Army's past performance in this field leaves much to be desired. We have to do much better.
>
> It should be recognized that with the exception of road marches, very few officers have conducted many night offensive/defensive operations. There may well be a reluctance to accept the necessity of conducting this type of operation as a matter of course. The reasons for our failure to conduct night/continuous operations should be openly and freely discussed so that acceptable solutions can be found. Some reasons presented for failure to train at night include lack of command emphasis; fear of failure; fear of accidents; lack of training areas, time, or support; and lack of knowledge. Other reasons exist and should be explored.
>
> A positive attitude will be necessary to overcome some of the resistance to this thinking. An accurate portrayal of enemy capabilities will assist in overcoming this resistance. It will become quite apparent that night/continuous operations must be accepted as normal in combat against such a threat because of existing equipment and technology.
>
> While night/continuous operations should be considered as normal operations, they do pose certain problems. Disadvantages, such as limitations of equipment and man and fear of the night, must be balanced against the advantages to be gained by their employment.

Night/continuous operations affect all aspects of Army operations. It is impossible to consider the tactical aspects without considering command and control procedures, logistic support, fire support, Sister Service support, and psychological implications of such operations. In other fields, what effect will increased night/continuous operations have on the ability of the logisticians to support the operation? How long can the commander and his staff operate continuously? The troops? Will our forces be able to outlast the enemy? How can we train to improve our capabilities in this area?

To be successful in modern battle, all units must have the ability to fight, support, and sustain in all levels of visibility. Insufficient attention has been given to this important area. It is therefore necessary to emphasize night/continuous operations doctrine in what we write, review, and teach. We must insure we have the doctrine to win the first battle."/37/

While all of the above presents a realistic appraisal of the status of capabilities, attitudes, and what must be done, it links night/continuous separated only by a slash. Equivalence is an easy interpretation. They are not.

6.5. Material Development for Night Operations

Doctrine, material development, and training must be coordinated for mutual enhancement. Doctrine, to a large extent is driven by technological state of the art; however, it must provide timely, specific direction to the material developer.

Under the impetus of the Southeast Asian conflict, several crash development and limited production programs for night observation devices were realized. These high risk programs resulted in significant progress; however, a total system approach was not undertaken. Doctrinal guidance and time were too limited to permit commonality of subsystems.

The present material capability for night vision is predominately provided by near infrared, searchlights and pyrotechnics, which emit an active light source and often result in a compromise of security. The only extensive capability for covert operations is provided by image intensification which amplifies the ambient visible light. Developmental efforts are primarily in the area of image intensification and thermal imaging. Both are passive systems and do not emit a detectable signature; however, both approaches have inherent shortfalls. The image intensification devices are bulky and heavy with limited performance at low light levels, and thermal imagery is costly.

Thermal imagery, using infrared technology, demonstrates more favorable military application than image intensification and costs are being lowered, by using common components for numerous applications. It requires no active visible light source; is independent of any visible

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/37/ "Night/Continuous Operations", Faculty Bulletin 11, U.S. Army Command and General Staff College, Fort Leavenworth, 11 August 1975.

smoke, haze, and light camouflage; and, enhances daylight observation capability.

A shortfall of our material development program is the failure to use a total system approach by combining the capabilities of several STANO subsystems. For example, the PPS-5A radar set provides detection cues; the TVS-4 night vision sight provides recognition and identification cues; and the GVS-5 laser rangefinder provides range data. Each of these subsystems accomplishes complementary tasks.

Current night vision aids available to artillery forward observers with maneuver units do not have sufficient range to enable him to acquire targets and adjust fires. The improved ground laser locating designator will increase his capability by enabling him to engage moving, and point targets at night out to ranges of 3000 to 5000 meters. Projected developments in electronic and sound ranging capabilities include the AN/TPQ-36 mortar locating radar, the AN/TPQ-37 artillery locating radar, and the Field Artillery acoustic array locating system (FAALS).

A serious deficiency is the lack of a fully affective, 24-hour, short range air defense (SHORAD) system. The present system includes the Chaparral and Redeye missile systems and the Vulcan gun system. Although the Forward Area Alerting Radar (FAAR) provides position and identification information at night to SHORAD weapons, visual acquisition and identification are still required before aircraft can be engaged.

There is a need for a night vision system for Army aviation. In a high threat environment, Army aircraft will not be able to fly at high altitudes at night in order to avoid obstacles and facilitate navigation. Nap of the earth techniques will be required. The AN/PVS-5 night vision device provides an initial capability in this area but falls short of the requirements.

Summary:

* Doctrine to guide material developers.

* Commonality in design.

* Systems approach instead of individual single purpose equipment; combine functions.

* Emphasize target acquisition and damage assessment systems.

* Short range all-weather air defense systems is a weakness.

Implicit in most of the material development in the Army concept paper on night operations is that night vision devices will provide the primary means for achieving a night capability. All of these are ambient light dependent and will be severely pushed by the low ceilings and hazy visibility common in Europe in winter months. They are also blinded or at least degraded by smoke. Thermal imaging, far infrared, devices have the capability to penetrate smokes of certain particle size; white

diesel smoke, for example. However, the Soviets place heavy reliance on smoke. [See, for example, "Have Smoke Agents Become Outdated", by LTC Engmers K. Klase (East German), Military Herald, July 1965. He discussed particle size requirements for screening the far infrared region (and other applications).]

While not overlooked there are several material development areas that do not have the emphasis given night vision devices and battlefield target acquisition systems. In the context of a total system, these are also important functions essential to night operations on the modern battlefield:

* The hand-off problem.

* Navigation and position location.

* Battlefield identification.

The hand-off problem is part of the overall target acquisition function. Yet most effort has been directed toward sensors; very little to hand-off./38/ The fundamental problem in the European theater is in the hand-off of acquired target information to and among direct fire systems -- tanks, antitank weapons, artillery, aircraft, mobile air defense systems. Improvement is dependent on a common grid and on standard procedures and means among the services and NATO Alliance Forces./39/

There is a surprising lack of interest in battlefield identification within the operating forces. However, a survey of experienced combat commanders, a major study of Restricted Visibility Land Combat in the European Theater that was done by Stanford Research Institute,/40/ and the report of a large NATO panel convened to study limited visibility combat/41/ identified battlefield identification as a critical problem that must be solved. It is the Soviet intent and capability to force a highly fluid battle situation where large numbers of armored and mechanized units will penetrate deeply and rapidly in a sustained attack at the maximum achievable pace day and night. Every means will be used to create confusion.

/38/ For example, in 1972 work dedicated to target acquisition and surveillance valued at $22,000,000, 66 percent was allocated for sensors and related technology; 9 percent for target properties; 7 percent for processing; 9 percent for human factors; 5 percent for test and evaluation, and 4 percent miscellaneous. (Taylor, J.G. et al., "Battlefield Target Acquisition Technology (U)", Systems Planning Corporation, Arlington, Virginia, March 1973, SECRET).

/39/ "Restricted Visibility Land Combat Analysis - Summary and Overview (U)", Technical Report 1922-2, Stanford Research Institute, August 1973, CONFIDENTIAL.

/40/ Ibid (previously cited), p.2.

/41/ "Study on Fighting Under Conditions of Limited Visibility (U)", NATO AC/243-D/143, AC/243 (Panel 1), D/26, October 1971, NATO CONFIDENTIAL.

Most development money for navigation and position location is being spent for costly systems that will depend on electromagnetic radiation (LORAN, satellite). These systems, when they are finally developed, can provide more accuracy than necessary for most operations of tanks and mechanized infantry combat vehicles. A less expensive, self-contained system comprised of a gyro compass, the vehicle odometer, a basic computer, and an appropriate readout device can satisfy the navigation and position location requirements of most combat vehicles. Our tanks and combat vehicles do not have this equipment. Soviet combat vehicles do./42/ Tankers would very much like to have equivalent equipment./43/

In establishing requirements for the Basis of Issue Plan's (BOIP) for continuous combat, it is equally important for logistics, maintenance, medical, engineers and combat support units to have whatever night vision, navigation, identification and other technological systems that will enable them to sustain and support operations without pause or let-up at whatever pace may be demanded. It is easy to assume that the issue plan must first equip the combat forces then the support forces. However, a balanced force capability is essential for staying power on the battlefield.

6.6. Night Training

Only through training can the Army realize its night operations goal. Doctrine and material are only as effective as the people who use them.

The Army's training program is implemented in:

* Basic Combat Training (BCT)

* Advanced Individual Training (AIT)

* TRADOC Schools

* FORSCOM Schools

The analysis done by CACDA in developing the Concept Paper on Night Operations analyzed data for Fiscal Year 1974 and the previous summer. It revealed that units are meeting minimums. However, these minimums are so low that it is doubtful that a real capability could derive from the training. In fact, limited training emphasizes that night operations are special and to be feared. This leads to a lack of confidence.

A recap of AIT as a percent of training given to night operations ranges from a high of 8.6, Infantry, to a low of zero for Air Defense with the average less than 1 percent.

/42/ "Soviet Technological Preparation for Night Combat", Captain Eugene D. Be'tit, U.S. Army, Military Review, March 1975, pp. 89-93.
/43/ Technical Discussion, U.S. Armor School and Center, Fort Knox, March 30, 1976.

At TRADOC schools: Infantry 2.61 percent, advanced course; basic course 15.88 percent, other infantry officer courses, about 11 percent. Ranger course: 33 percent.

Field Artillery: Basic course 6.3 percent, others range down to .34 percent. Armor: A high of 6.63 for the NCO course to a low of 0.62 percent for the advanced course.

Engineer School: 11.33 percent for the basic course to .55 percent for the advanced course.

Aviation: About 13 percent of the aviation courses are devoted to night training.

FORSCOM has a policy of decentralized training. A training guidance letter of 9 July 1975 directs that commanders conduct one-third of all collective and individual training during hours of darkness. Units report that they are meeting this requirement.

A survey was made of FORSCOM personnel (22-30 July 1974) to learn how commanders might structure night training programs. These were the results:

* Priorities may have to be revised before the Army can achieve a high level of effectiveness in night operations training.

* Safety requirements tend to hinder night training effectiveness.

* Major training exercises do not adequately emphasize night operations.

* There is a need to increase the amount of night training and instruction in the training base (BCT and AIT).

* Training on night vision devices is hampered by shortages of equipment.

* Current night operations training do not increase the confidence personnel have in their night skills and unit night operations capabilities.

* About half of the enlisted personnel were not satisfied with the quality of night training.

* About one fourth of the enlisted personnel stated that frequent use of night vision devices would be harmful to their eyes.

* Over half of the enlisteed personnel queried favored more night training.

* Night training exercises are not designed to require maximum use of STANO equipment.

Interviews with Commanding Officers yielded some insight into the

problem of training for night combat operations. All commanders see night combat operations as routine and a normal extension of day combat operations. Regarding doctrine: "We still tend to apply techniques used during day operations to night operations. The techniques are completely different." While STANO devices offer a valuable assist, training is the key to improving night operations capability. Fifty percent of our training should be at night. All commanders stated that more night training was required than had previously been conducted. Priorities must be revised before the Army can achieve a high level of effectiveness in the conduct of night training. As one commander put it, "I have too many number one priorities. A decision is required on what responsibilities will have to be reduced or eliminated." (The type priorities referred to include in part, support for ROTC, Army Reserve and West Point training; preparation for Reforger exercises in Europe; recruitment under unit-of-choice programs; civilian education programs conducted during duty hours; and training requirements other than for night operations.) In order to meet safety standards all vehicles are required to keep headlights on at night, and movement of company sized units or larger at night is prohibited. Guides with lights are required to walk in front of all vehicles. Major training exercises should emphasize night operations. Night movement was prohibited during Brave Shield XI. The importance of improving our night resupply and maintenance capability was stressed. Enemy air will severely restrict many combat service support functions during daylight hours. Night maintenance capability was designated as the area needing the most improvement. Night operations training in BCT, AIT, and TRADOC service schools do not teach the details required for successful night combat, and BCT and AIT fail to orient soldiers toward night operations. The advantages of night combat operations and the value of night vision equipment should be stressed in the training base and unit training. The rapid turnover of personnel was listed as a major problem affecting all training programs. The following needs were also identified:

* The need to stress the basics such as use of the eye, night firing and movement at night.

* The importance of interesting, well-conceived, and well-executed training programs which stress learning by doing.

* The need for competitive programs which assess individual and unit accomplishments. Feedback is essential in order for soldiers to assess their individual accomplishments.

* A need for instructional material such as pamphlets which provide guidance, teaching important points using simple scenarios and solutions. This might properly be addressed in the Army Training and Evaluation Program (ARTEP).

* The desirability of DA to establish specific night operations training goals.

* The need for training areas which are not surrounded by artificial light sources.

One brigade and eight battalion commanders were interviewed. The following is a compilation of comments received during discussions with these commanders.

* It is difficult to effectively train one brigade. A division "slice" makes training more meaningful.

* The decentralized training concept is not fully effective at battalion level because of higher headquarters' requirements which limit the flexibility that should be given to battalion commanders.

* Night training in garrison is difficult because of the day time requirements of the division. Also, wives continually call to find out why their husbands aren't at home. Extended periods of field training is the answer.

* The rapid turnover of personnel is a major problem in obtaining a high level of proficiency in night training.

* Resupply should be accomplished at night, but isn't. DISCOM does not train at night except in support of an FTX, and this impacts on our ability to resupply at night.

The ARTEP is a program designed to evaluate a unit's ability to attain a specified goal through training. The ARTEP would be an ideal method for evaluating a unit's ability for night operations. However, a review of selected ARTEP's indicates that they do not accomplish this purpose.

The major barriers to successful traiing are:

* Training priorities

* Safety requirements

* Equipment availability

* Rapid turnover in personnel

* Restrictions in major training exercises

* Limitations in training areas.

There are too many number one priorities. Safety requirements often make realistic training impossible yet, if personnel are injured or worse, and any of the "safety is paramount" requirements were ignored in the interests of realistic training, the commander's career is in jeopardy. Night equipment is not generally available and consequently, has not been assimilated into doctrine and tactics to optimize its use through familiarity. Many of the Project MASSTER test reports comment on

lack of equipment capability, large bulk and weight, and the difficulty in fitting equipment in combat vehicles. Even in Project MASSTER tests, the rapid turnover in personnel is consistently reported. (The Soviet's seem to draft their conscripts in batches so that a two-year training cycle covers all the essential aspects of training -- winter, night, NBC./44/ The Red Army training year starts in October and is divided into two parts, summer and winter, of equal length and importance).

Major exercises are the only opportunity to work out large scale coordination, interservice, and command and control problems yet restrictions -- fiscal restraint, "real estate" limitations, interference with civil activities from TV to airline routes, community relations, and always, safety -- dilute both the training of personnel and what can be learned about doctrine, tactics, and coordination. Night movement, for example, was prohibited in BRAVE SHIELD XI. Limitations on training areas is a severe restriction, particularly in Europe.

Not stressed in the above discussion of problems are some of the peculiarities of sustained combat. Man is a day animal and has a diurnal biological rhythm. There is a marked fall-off in efficiency and judgment at night. It takes several days to adjust to a night cycle. Reverse cycle training is an approach to both night and sustained combat training that could overcome this and many training limitations discussed earlier.

Probably the best trained U.S. division in night operations is the Second Infantry Division in Korea. Each maneuver battalion is required to undergo "Reverse Cycle Training" for two weeks every three months. However, even though this division is in the field and free of post support requirements, and its commander is serious about night training, practice for its night mission is done only 8 weeks per year; 16 percent of the time./45/

There is agreement among the combat troops, officers, and commanders, that not enough night operations are conducted and that 50 percent is a reasonable goal for night training. Reverse cycle training has been proven effective and is essential if continuous operations training is even attempted. Why not simply go to reverse cycle training on alternate months? This question was posed in technical discussions at the Marine Corps Base, Twentynine Palms.

There are actualities of peacetime military life that work against it. Post responsibilities, family life, community relations, other priorities (touched on earlier), New Volunteer Army amenities. It might be workable if combat forces were determined to gain the capability for

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/44/ For a outline of the Soviet recruit's training cycle see "Soviet Army Winter Operations", Colonel Erick Sobik, Federal Republic of Germany Army, Military Review, June 1973; translated from Truppenpraxis, FRG, November 1972.

/45/ "Net Technical Assessment of U.S. and U.S.S.R. Capabilities to Conduct Continuous Combat Operations During Periods of Restricted Visibility (U)", C. J. Lowman, Jr., and others; Systems Planning Corporation (SPC 274); 31 August 1976, SECRET.

night and continuous combat operations. But the entire post or base would have to go reverse cycle from bowling alleys to the Post Exchange. To keep family life intact, schools might also go on reverse cycle sessions. Even the community, where it is a military base dependent community, could accommodate to an alternate month reverse cycle. Having the entire base on reverse cycle would also insure that maintenance, logistics, and other essential combat support, even medical, would be coersed into a night and then a sustained combat way of life.

The FORSCOM goal of one third for night training has precedence in that the Chief of the Armed Field Forces in 1951 also "recognized the strong necessity for night training" and issued a directive stating that, "a minimum of 33 percent of individual and team performance on all tactical training ... be conducted during the hours of darkness." Because half the normal 24-hour day, on the average, is night, 50 percent might logically be established as a goal. This is the Soviet goal for night training and is the percentage recommended by many enlisted personnel and commanders contacted in the night operations survey.

Goals like this usually are met because they must be. However, every opportunity to record night training is taken and the goal becomes the goal. Realistic training for combat should be the objective.

Hard, tough training is encouraged by the Secretary of the Army. And it should be because training for combat is, or can be, literally a life and death matter. Yet, safety considerations are enforced to the point that effective combat training is not possible. Only time is spent and this adversely affects the morale of officers and men alike. Where the training is made tough, congress and the media can and have come down hard, often unreasonably./46/

All of the above barriers, artificialities, and limitations on night operations notwithstanding, imaginative interesting training is perhaps the most difficult aspect of training to achieve and possibly the most important. The problems dicussed above can be overcome once it is realized that a capability for continuous combat is vital to U.S. national interests as a credible deterrent to the Warsaw Pact threat. However, it would remain a most difficult matter to achieve night combat training that at once would psychologically bolster and build confidence and morale, yet at the same time make night training interesting; not a chore or something to be feared. This may be the most difficult challenge and where considerable work, study, and research should be dedicated.

/46/ It would be interesting to know how many young men are injured and killed in football training each year compared to the to the casualities that occur in military training. Hard training for football is expected; it's a rough competative American sport and injuries are accepted. Competitive combat training should be even more serious and tougher. "The best form of welfare for the troops is first class training" (General Erwin Rommel).

6.7. Current Doctrine and Shortfalls

The Doctrine Workshop of the conference on night operations convened by TRADOC at the Combined Arms Center 29-31 July, 1975, came up with the following findings:

"Current doctrine for night operations is so fragmented among our manuals that it is difficult to ascertain what our night operations doctrine is. Also, a common approach to night operations is not evident throughout the manuals.

The Army does have a common goal for night operations which will contribute toward revising and refining doctrine.

Present doctrine does not address current night combat equipment and technology. It should include not only our current state-of-the-art, but also that which will be available within the next one to three years.

Doctrine in our present manuals does not address the threat, nor is it scenario-oriented, as are the "How to Fight" training circulars.

Current doctrine does not adequately consider all aspects of logistic support at night, specifically: increased ammunition and POL requirements, increased maintenance, and medical support.

Other aspects of night operations not sufficiently covered in our manuals are orientation, navigation, identification friend or foe, camouflage, cover and concealment, target acquisition, and damage assessment.

A total system approach is not used in our publications on night operations. The total system should include enemy and friendly material, devices, forces, units, missions, terrain, and tactics for the offense, defense and retrograde.

Complete manuals which tell a battalion, company or platoon commander how to fight his unit at night are not available.

Continuous operations are not defined, and doctrine is not available in capstone manuals such as FM 100-5. These manuals should form the basis upon which the other manuals are written.

Current doctrine treats night operations as something special and not as a normal part of continuous operations. It does not emphasize the advantages and normalcy of operating at night.

The TOE's and BOIP must be considered when writing doctrine. Present TOE do not allow for shifts of personnel throughout a 24-hour period, which would be required in night and continuous operations. Once doctrine is revised and tested, the BOIP should also be reviewed and revised if necessary.

At present, material appears to be driving our doctrine. While this will always be true to a certain extent, doctrinal guidance should be provided to the materiel developer.

Field manuals need not contain lengthy, detailed technical information on night operations equipment and devices. This information can best be presented in the user's TM, or in a TM listing all such equipment. Basic employment information on types of equipment, however, should be in the manuals. A limited amount of technical information could be included in an annex, which could easily be updated without necessitating a complete change of the manual.

There is a need to test our doctrine to determine its validity. This can be done through FTX's, war gaming, SCORES and the ARTEP's. The test recently conducted by the Armor School was a good start.

Night operations doctrine must be consistent. It is especially encombent upon the Infantry and Armor Schools, as well as the Command and General Staff College, to insure that it is. This will necessitate a continuous exchange among all of these schools, and the other participants in the conference. It may also require additional conferences and meetings.

Human factors are extremely important aspects of night operations and continuous operations, and are basic to the devlopment of doctrine. Effects of sleep loss, adaptation to the night environment, and rotation of personnel are key considerations.

The Basis of Issue Plan (BOIP) should be based on mission-essential tasks. The priority for issue should be based on a unit's proximity to potential areas of combat, and should include a complete slice of the combined arms team and its supporting elements. If the logistics elements cannot function at night, it is doubtful that the elements which depend on their support can function either.

The enemy has much the same capability that we do in night operation materiel.

A night operations manual should be retained; however, it should cover only those areas which would be common to all of the manuals, such as the psychological and physiological effects of night on the soldier.

There is a need for a high level steering committee or agency with tasking authority to oversee night operations and continuous operations programs. This will insure that doctrine is consistent and compatible throughout the Army, and that all TRADOC, AMC, and FORSCOM programs are fully integrated and complementary.

The first step in developing or revising doctrine is to determine just what we want to accomplish at night, based on the Army's goal in night operations."

These are very straightforward findings by professionals familiar with the problem and have been presented as they were written. Some new "How to Fight" manuals have been written as a result.

The keystone recommendation that doctrinal guidance on continuous combat operations be promulgated in the new FM 100-5 "Operations" (1 July 1976) has not been done. A steering committee at high level would certainly move the achievement of this most critical capability toward reality.

The conclusions of the 1968 Carlyle Barrack's study of Continuous Operations that the two kinds of operations, night and continuous, should not be confused, that there is a lack of understanding of the dimensions and impact that gaining that capability would require, and that there are no on-going programs directed to continuous operations still apply.

7. Essential Elements in the Achievement of Combat Capability

7.1. Essential Elements

The capability for continuous combat that is made possible by advanced technology can be realized only by forces that are organized, trained and equipped to carry it off. Advanced military thinkers like Guderian and Fuller have written about the advantages of the capability for sustained combat and the flexibility given the battle commander. Guderian showed what could be done in his drive through France to the channel ports. The Soviets were so convinced from what they learned in the Belorussian campaign that they have made continuous combat the main principle of their combat doctrine and have implemented that conviction by becoming fully night capable and by the complete mechanization of their combat forces.

Maintaining the pace of modern combat, because of dependence on machines and technology and because of the lethality of modern weapons, cannot be achieved by additional planning factors or by simply increasing emphasis on night combat. It will also not be possible to make ad hoc adjustments under the press of combat because human endurance capacity is a central issue as is continuity in all essential combat and support functions.

The essential elements in the achievement of the capability for continuous combat are:

- Doctrine
- Organization
- Training
- Equipment
- Technology

These are probably in order of importance. Obviously, each element interacts with and drives the others. For example, technology has rarely been the major factor in the achievement of military success. It has rather been the innovative use of technology by imaginative military thinkers who, using the same technology, achieved extraordinary victories over opponents who remained conventional in their doctrine and organization. A modern warfare example is the use of tanks in the German blitzkreig tactics of Guderian and others rather than as a mobile pill box for the support of the infantry on foot, a carryover from WWI. The Soviet doctrine of the continuous offensive is today's example.

Doctrine is the driving element. If doctrinal guidance is not provided then only a fragmented capability for sustained combat operations can be achieved. The Soviets have already made this most important step. The Soviet military writings manifest in the Frunze Academy documents, Sokolovskiiy's "Soviet Military Doctrine," Savkin's "Operational Art and Tactics," Siderenko's "The Offensive," present in tactical detail the concept of the continuous offensive.

If continuous operations is the key to modern combat as it has been established in Soviet doctrine, then it must become the keystone also of U.S. and NATO doctrine and military thinking. Organization is derived from and based upon doctrine; training is then directed to its implementation; equipment and weapons provide the means; and technology puts the edge on the weapons and can, if properly directed, provide superior equipment. Some aspects of the organizational implications of continuous combat are discussed in this section.

7.2. The Influence of National Objectives

What was not included in the essential elements to military capability, National Objectives, may indeed be the most important since they provide the framework and the bounds within which those responsible for military requirements and effectiveness can work and the reason for having a military capability at all. One primary national objective, which influences every aspect of the development of military doctrine and organization, is the United States guarantee of the integrity of Western Europe. Commitments to NATO for the defense of Europe are based on the following assumptions:/47/

* Some days of warning before attack (thirty days or more was once the accepted estimate).

* A large supply of reserve war materiel on hand in Europe sufficient to support massive land and air offensive and defensive operations similar to those of World War II until supply lines over the Atlantic can be established and filled. Ninety days has for a long time been the U.S. estimate of time required to start pipeline flow, and hence ninety days of supplies are needed on hand in Europe in peacetime.

* The continued maintenance of such Atlantic supply lines, after their initial establishment, for an indefinite period of hostilities.

* An initial supply and subsequent flow of petroleum products in large quantities to support extensive land, sea and air operations much like those of World War II, but possibly on a larger scale if hostilities last for long.

* Ports and airfields to receive such materiel.

* Effective road and rail networks to move large masses of men and materiel internally, and from debarkation points to where needed in Europe.

* NATO control of the air and air support for NATO ground forces.

/47/ Captain John H. Morse, "Questionable NATO Assumptions," Strategic Review, Winter 1976.

* Airfields and air base facilities adequate to:

  - Receive and distribute or support incoming men and materiel, including several hundred U.S. airplanes scheduled to land shortly after hostilities start.

  - Support massive World War II-style air operations, first to gain control of the air by manned aircraft, then to support whatever NATO ground operations are still in process by that time.

  - Hold a number of stand-by nuclear attack aircraft ready in case and until NATO political authorities decide to use nuclear weapons.

* The Soviets not using nuclear weapons up to that point.

* The Soviets not using chemical weapons at all.

* NATO naval operations in the Mediterranean, including particularly those of the Sixth Fleet, and its carriers, protecting NATO's Southern Flank.

* Extension of Atlantic supply lines in the Mediterranean to support naval, land, and air operations in the Southern Region.

* Timely decisions by NATO authorities, as well as by the U.S. President, to use nuclear weapons when and if hostilities cannot be halted by conventional means.

* NATO nations continuing to act in concert when one or all are under attack, and to provide and support their forces now committed or promised to SACEUR for his command.

Current U.S. and NATO concepts, organizations, and force structures for defense and deterrence allow, in effect, only two alternatives should deterrence fail: 1) all or most of the assumptions listed above must hold valid while European and U.S. troops fight to defend Europe indefinitely; or 2) the U.S. uses its strategic nuclear power.

The organization, force structure, positioning of combat forces and concepts for the defense of Europe are also influenced by military goals. The Soviet's goals are "war-fighting and war-winning"; the U.S. goal is war avoidance./48/ For NATO it is a commitment to a strategy that precludes winning. The best that can be achived is a stalemate with the least loss of ground. There is also a clear lose possibility.

This national policy has resulted in the military principle of the Forward Defense. It has been "manifested by the fact that several parties to the Alliance are maintaining operationally ready forces close to the country's (West Germany) eastern border."/49/ The principal party,

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/48/ "United States Military Posture for FY 1968," by Chairman of the Joint Chiefs of Staff, General George S. Brown, USAF.

of course, is the United States whose forces are drawn up tight alongside those of our German ally.

Many NATO military and political leaders conclude that the U.S. Army forces in Europe, are out of position./50/ The northern plains of Germany is the likely area for the tank saturated, mechanized continuous offensive projected by the Soviets. A recent RAND study of the U.S. V Corps terrain indicates that this conclusion merits serious consideration. The Fulda Gap terrain is not suited to the tank and mechanized infantry combat formations required by Soviet tactics and doctrine.

To meet this contingency a U.S. brigade is deploying to the North German area. This brigade, and a second one also dispatched to Germany, are part of Senator Nunn's "Tail-to-teeth" amendment which is discussed below.

7.3. The NATO/Warsaw Pact Dichotomy

There is a dichotomy in the organization, doctrine, and concept of modern warfare between U.S. and NATO combat forces (which partially mirror the U.S.) and those of the Warsaw Pact (which do mirror the Soviets). It is centered around the perception, impact, and implications of continuous combat -- the capability to maintain (or resist) the offensive day and night and in poor weather and visibility. This is where the Soviet concept of modern combat gains enormous leverage and where the U.S. and NATO yield the advantage.

The U.S. division structure and supporting theater forces prorated per division, the division slice, are much larger than the Soviet/Warsaw Pact divisions and division slices. The Soviet forces have small highly mobile units, 18 battalions per 12,000-man mechanized division and a 17,000 division slice against the United States' 12 battalions per 16,000 man mechanized division and a division slice of 48,000 for wartime theater forces.

The Soviet concept is to echelon forces so that the intensity of the offensive can be maintained at the points of combat contact along the main thrusts. A unit is used up, exhausted, then replaced in kind by a fresh unit. Logistics, maintenance, medical, engineers and other combat and combat service support have been pulled back to Army and are assigned to those units having the greatest need based on combat activity and objectives.

The U.S. concept is based on having each division, to a large extent, autonomous and self-sustaining. It has its own share of logistics, maintenance, headquarters, administration, and other support personnel. Combat losses in men and materials are made up from replacement pools. It is a concept that depends on having time to mobilize and equip for a war that would grind the enemy down by the sheer weight of the material

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/49/ White Paper 1975/1976, "The Security of the Federal Republic of Germany and the Development of the Federal Armed Forces."
/50/ "Can America Win the Next War", Drew Middleton, previously referenced.

strength and industrial capacity of the United States. It is appropriate for a long war; a war that the Soviets could not win. It is not suited to the Warsaw Pact continuous offensive; a war that the U.S. and NATO cannot win as they are organized and configured, not even if nuclear weapons are used.

7.4. Organizational Considerations

The matter of the organizational differences and the war-fighting capabilities of the United States and the Soviets has been the subject of critical congressional interest for several very good reasons. The United States no longer has strategic nuclear dominance. The Soviets are equal to and in many ways ahead in tactical nuclear war fighting capability. Their buildup of conventional air and ground forces in numbers and in weapons is beyond anything needed for defense. It is clearly configured for the offense. A deterrent to this Soviet threat, which is growing at such a rate as to represent a challence, depends on an equivalent or superior NATO capability for conventional warfare.

In testimony to the Senate Armed Services committee, General Alexander M. Haig, Jr., Commander-in-Chief, U.S. European Command stated that the capability of the North Atlantic Treaty Organization forces to cope with a challenge from the Warsaw Pact nations is less today than it was five years ago. "The heart of the effort," he said, "is the improvement of conventional land, sea, and air forces -- not because we view nuclear deterrence as less important, but we view a stalwart conventional capability as the prerequisite for deterrence, and because we view the deficiencies in our conventional posture are currently the most grievous."/51/

Congressional focus on present force structure resulted in the Nunn Amendment, a rider on the Senate Authorization bill for Fiscal Year 1975. This act requires a 20 percent cut in noncombat strength in Europe, 6,000 in FY 1975 and the balance in FY 1976 with authority to replace the supporting manpower thus lost with combat troops on a man-for-man basis. This is a clear effort to force a change from the concept of the autonomous divisions considered to be necessary for the American Expeditionary Force responsibilities of the Army. Since the Army forces in Europe are actually dedicated and committed forces, it is sensible to configure them in the most effective, efficient, and economical way to meet the Warsaw Pact threat and forego anachronistic expeditionary force considerations. The arguments center around what that configuration should be.

The fulcrum upon which the Soviet combat forces gain their leverage is in their perception, doctrine, traning, organization, and equipment for continuous combat operations; this salient point has become lost in "short war" "long war" arguments and in "bean counts" of men under arms and weapons, particularly tanks. It is vitally important to establish doctrine for continuous combat and from that well conceived doctrine to configure combat and support forces -- medical, logistics, maintenance

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/51/ "NATO Capability Seen Diminished," Aviation Week and Space Technology, March 7, 1977, p. 17.

-- to be able to sustain an unremitting combat pace, day and night without let-up. This should not be confused with the "staying power" of the present division organization. The latter connotation is based on the traditional intermittent concepts of warfare with diurnal changes in combat pace and intensity. It is a "production line" war where the assumptions upon which the defense of NATO is predicated (stated earlier) hold, mobilization is in effect, supply lines are open, control of the air established, and the enemy can and will be defeated by the overwhelming industrial capacity of the NATO nations, particularly the United States, using essentially the organization, doctrine, and methods of the last war.

While continuous combat capability is the center of the problem the dichotomy in the Warsaw Pact and NATO force tank and mechanized infantry division organization is clear cut. The numbers of men assigned to a U.S. combat division as well as the support forces in the theater for that division are very much larger than Soviet divisions and support forces. Yet the Soviet divisions have more guns, combat vehicles, and more support and logistics vehicles in types and numbers as well. Since these modern combat forces are in the same theater, are likely to be at war with each other, or at least this is the contingency that must be faced, and have equivalent equipment, the conclusion can be reached that both concepts of doctrine and organization cannot be right.

7.5. Restructuring/52/

There is a persuasive rationale for restructuring if not in the clear numerical disparity that exists between U.S. and Soviet division organization then in the mood of congress, the pressure on the military budget, and the erosion of inflation. NATO forces must be restructured to counter the continuous offensive by echeloned tank heavy mechanized forces that the Warsaw Pact forces have projected. This should be possible if agreement can be reached among NATO leaders that it must be done, and there is a realization that the rapidly increasing disparity in war-fighting capability between the combat forces of NATO and those of the Warsaw Pact has become critical.

NATO has more men under arms and spends more on weapons than does the Warsaw Pact yet has less combat power. Readily apparent measures like standardization, interoperability, shared resources, apportioned research, common development and manufacture of weapons and materials are more difficult to implement in the "tower of babel" environment of NATO than in the monolithic and Soviet dominated Warsaw Pact alliance.

The most useful way to achieve a war fighting capability and to have better coordination and economy is to develop a common doctrine that is specific to the Soviet continuous offensive concept of war in Europe. Organizational concepts are derived from doctrine. The general purpose expeditionary force American and British organizational con-

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/52/ "The Alliance and Europe: Part IV Military Doctrine and Technology", by Steven Canby, Addelphi Papers Number One Hundred and Nine, International Institute for Strategic Studies, London.

cepts, appropriate for a division to operate autonomously if necessary anywhere in the world results in larger, less efficient and more costly forces than are required. It is vital that they become responsive to existing realities in Europe. They are oriented towards infantry warfare not a rapid armored attack. They are organized for traditional diurnal peaks and valleys of intermittent combat with some improvement in capability to operate at night, not for sustained combat. Logistic concepts and anticipated types and quantities of supplies are based on combat experience which has been traditional, infantry oriented warfare.

Armored warfare does not require the logistical balance that an infantry-style, aross-the-front deployment requires. In addition, short conflicts require less maintenance and far fewer logistics troops than longer conflicts. A short violent conflict does not depend on "production line" maintenance, repair, and upkeep concepts. More important is equipment designed for easy, modular, component replacement and fast battle repair by maintenance personnel using advanced concept mobile repair vans. Engineers, repair personnel, chemical, biological, and nuclear radiation specialists can be concentrated where combat activity is highest and the need greatest if these specially trained personnel are pulled back to higher organizational control and not distributed across the theater for division autonomy. This can be done by adopting a task force concept of organization specific to combat in Europe as opposed to an autonomous, expeditionary organization with universal applicability and "staying power."

The rationale presented is that a military force configured and organized to fight continuous, intense armor-centered combat, which by its pace and lethality is necessarily "short", can be configured and augmented to fight a longer, more traditional war by planning for that kind of augmentation. In fact, the combat forces in place upon which this burden and responsibility will fall as stated in FM100-5, will have accomplished their purpose by stopping the offensive allowing the opportunity to mobilize and adjust the support and combat force balance for the "long" war, a war that the Soviets will lose. If, however, a balanced force is maintained, based as it is on intermittent albeit night emphasized doctrine, and the present organizational concepts are retained, there may not be the opportunity to mobilize for the "long" war.

The Soviets have developed the mechanism of the echelonment of forces which is suited to the continuous offensive and for waging a short intensive campaign. As pointed out by Savkin ("Operational Art and Tactics") this forecloses NATO's ability to mobilize, makes a nuclear decision difficult, and weakens the resolve of NATO Allies. They have streamlined their formations by recognizing the economies of blitzkreig tactics and the requirements for continuous combat in exploiting unrelenting pursuit. Their study of their Belorussian campaign has convinced them that fewer men are required and their overall losses will be much less. This has been documented in the unclassified Soviet military thought series. NATO Armies, on the other hand, have tended toward an American-type reserve and replacement system while the Soviets have updated and modified the German-developed mobilization concepts designed to flesh out rapidly a large Army and to surge over her opponent in a quick campaign like that projected in Siderenko's "The Offensive."

7.6. Some Actualities of Restructuring/53/

There is not agreement on the advantage or the necessity to restructure. Immediate combat power will be increased at the expense of staying power. It has been stated that the emphasis on the importance for restructuring has been placed on the lessons learned in the October 1973 Arab-Israeli war; a short, violent war perhaps not wholly applicable to the problems facing the U.S. Seventh Army in Germany. However, if this is so then not enough attention has been paid to the continuous combat war-fighting capability that has been developing in the Soviet Union for more than two decades.

Conflict in Europe will be violent in the extreme; more violent perhaps than the October War. Casualties in men and material will be high. Consumption of ammunition and petroleum, oils and lubricants (POL), the big tonnage items, will greatly exceed what we have come to expect. Attrition rates will be high, with a premium on rapid turnaround of battle damaged vehicles.

The automatic data processing (ADP) means for projecting demands and setting stock levels for the expected type of combat in the theater does not have a data base for sustained combat between modern mechanized forces because there has been no combat experience upon which to establish that base. Rate of expenditure will be much higher but the duration necessarily shorter. If mounted combat is the norm, as projected by Sokolovskiiy, and combat will go through the night, what about small arms munitions requirement? Down because infantry style foot combat does not apply or up because of increased combat pace? Illuminating rounds were used extravagantly in Korea. Will they in continuous combat in Europe, or will night viewing and target acquisition and surveillance equipment be in such general use that there is an advantage to keep the battlefield as dark as possible? The Soviet concept is to light the battlefield after contact. Since there will not be an opportunity to learn in combat and adjust, these data need be developed now from war gaming and computer projection of the modern continuous combat battlefield. However, to do this, first the character of modern continuous operations needs to be thought out and formulated into doctrine.

The Israelis, by using forward, mobile maintenance vans, repaired and turned around more tanks and mechanized combat vehicles than they had. The concept of forward based maintenance vans with concentration of these support vehicles and specially trained technicians where combat activity is highest is described in Soviet concepts of modern warfare. This task force assignment of support personnel on the basis of combat activity tailored for special requirements is an advantage that can be had without increasing manpower requirements. It can be done by pulling logistics, maintenance, medical, and other specialized combat support personnel back to Corps, keeping combat units, to the extent possible, strong in combat personnel, weapons, and vehicles and dependent on tailoring for support as a function of objectives and expected activity.

/53/ "The New Short War Strategy," General James H. Polk, U.S. Army (ret.) Strategic Review, Summer 1975.

Combat intensity will not be uniform throughout the theater so combat support should go to the greatest need.

Rear base maintenance upon which a "production line" war depends may not get into production if advanced forward maintenance concepts are not developed. Because land warfare is becoming increasingly dependent on machines, the victor is likely to be the one who can keep his machines operating and can turn around battle damaged machines faster.

We have always prided ourselves in our humane concern for the wounded and in our responsibility to the dead. Because of the pace of continuous combat and the lethality of modern weapons, casualties will be very high. In the furious battle situation characterized by rapid change and a lack of a front line or clear demarcation between friendly and enemy forces, how will wounded be recovered and the dead buried or gotten out of the theater? Since there will be no let-up at night, finding the wounded, treating shock, and getting casualties out of the battle area will be difficult. The Soviet concept is to use specially trained dogs to find the wounded and the dead. As in the maintenance of vehicles, medical teams specially trained in chemical and radiological casualty treatment are based forward in specially equipped vehicles. Rear area hospitals and large, fixed medical facilities necessary for staying power can be established once the offensive is stopped. If it is not, then they are not necessary. Mobile forward medical vans, specially configured, and assigned according to combat demand, not distributed per division, are essential in the actualities of restructuring for continuous combat. These concepts of mobile maintenance and medical vans are exactly opposite to efficient and procedural peacetime requirements. Therefore, organizing to accommodate to this mode of operations goes against the grain. However, if it is not done now it will not evolve in the pressure and confusion of a modern war.

Dependence on territorial personnel to pick up a greater share of the burden in the rear areas, thus allowing a reduction in the theater division slice support forces presents a different set of problems. Their services are already spoken for in the support of their own combat forces.

The problems of processing and handling the huge volume of supplies that will pour into the theater has been a "horror" in the past three wars and has not been satisfactorily solved. With the reduction in logistics support and supply personnel who are experienced in supply problems, the matter will worsen. The new procedure in vogue, "direct resupply," wherein a requisition from the fighting unit goes directly and immediately back to the commercial supplier and is shipped for retail delivery by air freight has looked good on paper but a 30-day response time is typical. Like maintenance, the combatant who can best solve his logistics problem will gain a great advantage because of the machine dependent character and the intensity of modern warfare. It is primarily an inventory management, data and material handling problem; precisely where the Western nations, particulary the United States, claim to excell. ARPA methods of computer netting, high density computer memories, rapid and secure data transmission, satellite communications, artificial intelligence and computer learning procedures, and the

extensive developments in microprocessors and small computers can be brought to bear on this problem. The justification for large numbers of support personnel to manually sort out and process supplies cannot be valid. Advanced technology can be made to work. While not as glamorous a research problem as many, it is one that would have a major impact because it has not been solved according to commanders knowledgeable in the actualities of combat. It might not win the war, but it could surely lose it./54/

Much of the "tail" is considered to be untouchable. The military police are required to furnish guard companies for the safety and security of nuclear storage depots. The function could go out on local contract but it probably will not. However, can advanced technology methods be applied to reliably safeguard these most vital weapons with a minimum of personnel? If not, then these supporting guard personnel cannot be touched.

The Medical Corps is not likely to be reduced because at present strength and staffing it is barely able to keep up with peacetime ills and treatment of dependents. Depending on local medical support will not work because these resources will be required to handle their own national problems in the event of a war.

Communications personnel are not likely to be reduced. There is a Parkinsonian-like law that demands more information be provided to higher headquarters as a function of the increased capacity of advanced technology communications to supply more information. Communications support personnel requirements are likely to increase.

The storage, processing and forwarding of ammunition is a critical function and a particularly vital one in an intense war. It is a service that cannot fail. Dependence on territorial personnel for drivers and handlers of dangerous cargo is chancy. This is another area, however, where advanced technology and research can be applied with the potential of a major impact on combat effectiveness and a reduction in support personnel. Ammunition is crated as it always has been. It is uncrated forward in the immediate combat area. This requires a great deal of manual handling, and therefore large numbers of support personnel, a scarce and expensive commodity. Liquid propellent guns would have a big pay-off in reducing logistics handling and support personnel. Missile concepts where the firing tube is also the shipping container not only save bulk but handling as well. The entire area of ammunition handling and supply in continuous combat conditions needs examination. Established methods may prove to be a bottleneck. Because of the large numbers of targets that each NATO tank might have to face if it were in the main attack axis, it would likely exhaust its basic load. Getting a resupply in combat has never been a serious problem. It was in the Arab-Israeli October War; it will be in Europe. The logistic support companion vehicle to the hard-shelled self-propelled gun has a soft

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/54/ The matter of combat logistics is apparently not a modern problem. "For the want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of the horse the battle was lost."

shell. When the SP artillery piece goes through its basic load it must leave the combat environment to go to the soft shell support vehicle.

There are strong positions on the wisdom of maintaining a balanced force and the expeditionary force autonomous character of the present division organization. Configuring for the intense "short" armor centered war, it is argued, does not provide a hedge for the flexibility to respond to other crisis areas. These considerations merit careful analysis. But it seems overwhelmingly persuasive that a doctrine and organization specific to the threat of the continuous offensive in Europe must be developed if there is to be a long war to contend with.

7.7. New Division Organization Concepts/55/

The Army will test a new type of division organization designed to concentrate firepower and increase unit responsiveness on future battlefieds.

The concept, developed by the Division Restructuring Study Group (DRSG) within the Training and Doctrine Command (TRADOC), takes account of trends in precision-guided weaponry in which increasing amounts of accurate firepower will be directed by small, mobile front-line teams, but delivered from areas further to the rear.

This means that the number of men per linear unit of battle front is decreasing, but that firepower per man is increasing -- often by several orders of magnitude.

The main points of the DRSG proposed organization are:

* Smaller, more agile battalions and companies but more of them per division.

* Concentration of heavy weapons at higher organizational levels, particularly antitank weapons.

* A 61- percent increase in the number of gun tubes in the divisional artillery.

* companies to be stripped down to single-purpose units without organic heavy weapons, with responsibility for integration of the combined arms shifted to the battalion.

* Common structure between tank and mechanized infantry battalions, to facilitate cross-reinforcement at that level.

* Division combat engineer resources to be concentrated on the job of increasing division mobility and impeding enemy mobility.

* Division supply and maintenance elements to be recast with an emphasis on resupplying and rearming units on the run without the necessity of their having to withdraw from the fight, and

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/55/ "Army Tests New Concept: Fewer Men, More Clout."

repairing their equipment on the spot as far forward as possible.

The DRSG places responsibility into the hands of the battalion commander and staff, leaving the company commander to concentrate on operating weapon systems and leading small, single-purpose units.

The consolidation of administrative functions at the battalion level or above that is now going on throughout the Army presages the time when the company commander will be purely a troop leader.

Infantry companies will be smaller and would lose their mortars and heavy TOW antitank weapons. The latter would be concentrated in TOW companies and a TOW battalion, while the addition of 36 155-mm self-propelled howitzers and four eight-inch guns to the division artillery is thought to obviate the need for mortars in the rifle companies.

Tank battalions would have 36 tanks instead of the present 54, while the numbers in tank companies would be reduced from five to three. A larger number of tank battalions per division, however, would have the total number of tanks as it has now.

With precision-guided artillery fire becoming a reality, the present division artillery organization would be overwhelmed by the new demands for more missions and more types of munitions, hence the need for more guns and more fire-detection nets.

Current U.S. divisions are, in any case, badly outnumbered in artillery by their Soviet counterparts. The artillery will also be called on for increasingly greater delivery of scatterable mines, smoke and chemical shells, even artillery delivered intelligence-gathering devices.

If the DRSG concept is approved, division combat engineers would drop the bridging company and add equipment to enhance front-line mobility, such as combat munitions for destroying minefields, as well as advanced mine-emplacement gear to set up defensive barriers.

This division concept addresses some of the problems of the modern continuous combat battle environment -- smaller, agile, battle units; resupply on the run; maintenance forward; pushing administration functions up the line; consolidating engineering functions. The primary reason for the new organization is to optimize the firepower advantages of precision guided munitions, to increase responsiveness, and to become more mobile. What is not apparent and what may not have been attempted are the organizational and equipment changes that are necessary if battle at an intense pace continues beyond the endurance capability of the individual. For example, in the tank battalions, does the TOE call for one crew per tank or is there a relief crew provided or some planned and organized and established doctrine for continuing the combat pace; an equivalent to the Soviet echelonment concept?

7.8. Summary

The essential elements to combat capability are doctrine, organization, training, equipment, and technology. These are interactive but the dominant and driving element is doctrine. Advanced military thinkers have always gained the advantage over conventional opponents by imaginatively using the same weapons and technology innovatively. Technology has made possible the complete mechanization of combat forces and makes possible operations at night and in bad weather. Continuous combat operations can be conducted by troops organized, trained, and equipped to carry it off. These essential elements derive from doctrine. The Soviets have established the doctrine of continuous combat and the echelonment of forces to sustain the offensive. U.S. and NATO armies have not. We have what is considered to be a superior technology base but have not equipped our operational forces for night and continuous combat to the degree the Soviets have. The rate of growth of their combat capability is so alarming and of such an offensive configuration as to represent a challenge.

Organization derives from doctrine and because continuous combat has not become a keystone in U.S. (hence NATO) doctrine, organization is based on a balanced, expeditionary force autonomous divisions suited for deployment and staying power wherever there might be a crisis. It is appropriate for intermittent intensity infantry style combat with an established front line, a continuous flow of supplies, control of the air and lines of communication, and a "production line" concept of logistics and rear area support. There is a wide dichotomy in the numbers of combat troops and in the supporting theater division slice between NATO and Warsaw Pact divisions. The Soviets have more firepower and combat vehicles yet far fewer men in both the division and in supporting forces.

Congressional pressure has forced a realignment in the ratio of combat troops to support personnel. Some very serious problems need be solved because some support personnel are likely not to be affected.

Training is developed to implement doctrine. Except for increased emphasis on night operations (discussed in the previous section) training specific to the demands of continuous combat has not been developed or even addressed because doctrinal guidance has not been forthcoming.

The organizational concept of distributing support forces uniformly per division is not as efficient or effective as assigning these units, tailored and equipped for high mobility mechanized combat, to where activity and need is highest and to meet the immediate military objective.

8. Impact on Air Support

8.1. Introduction

The war in Europe between the Warsaw Pact and NATO nations will be of an intensity seen briefly in microcosm in battles between Arab and Israeli forces in the October War. It has been characterized by Siderenko as:

* "Taking on great spatial size; conducted without let-up night and day in any weather.

* Highly mobile; dynamic; fluid; confused.

* Because there will be different degrees of defeat in the enemy there will be an uneveness of the development of the offensive. Even the term 'front-line' will be rejected for the more specific, 'the line of fighting contact of the troops.'

* High troop mobility; saturation of the battlefield with tanks; rapid and acute changes of circumstances; great expenditures of material; massive losses of troops and equipment."/56/

It is a war that will be fought by air and land forces working together with interaction and dependency extending into every function of combat. Because this is so, the implications of the requirements to fight without pause or let up, which has been discussed largely in the context of land forces, applies also to the air forces. The impact on Air Force doctrine, capabilities and requirements may be of even greater significance because of the immediate, intense, furiously paced and continuous demands on the Air Force, throughout the theater, and indeed all the way back to CONUS -- TAC deployment, SAC alert, in-flight refueling, air transport of men and materials.

8.2. Air Force Responsibilities/57/

The Air Force responsibilities in the air-land battle are:

1 Drive enemy air forces from the battlefield so that Army forces can exploit their mobility and mass at the critical places and times.

2 Provide reconnaissance and intelligence to the Army and the Air Force regarding enemy locations, concentrations, and movements.

3 Conduct battlefield interdiction operations -- that is, ground attack against enemy reserves, fire support elements, command posts, and supply points. This is probably the most effective use of tactical air forces because targets are plentiful and

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/56/ A. A. Siderenko, "The Offensive," Moscow, 1970.
/57/ FM100-5, Operations, Headquarters, Department of the Army, 1 July 1976.

attacks may be concentrated and sustained. The defeat of second and third echelon attacking forces before they even reach the line of contact is a main objective of such operations.

4 Provide close air support, wherein tactical fighter aircraft attack targets designated by the ground commanders. Close air support is increasingly difficult, but when the engaged Army forces require close air support to accomplish their mission, it must be provided regardless of difficulty and regardless of cost.

5 Provide tactical airlift -- that is, the movement of troops and supplies on the battlefield.

The basic missions of tactical air war are air superiority, interdiction, reconnaissance, and close air support.

The air superiority mission has first priority. The first order of business is to defeat the enemy's air power and remove his capability to deliver air strikes on friendly forces. Reconnaisance is always a vital need; however, reconnaisance aircraft are generally single purpose aircraft.

The relative priority of interdiction -- attacking the enemy supplies, personnel, and lines of communications before they get to the battle area -- versus the priority of close air support varies with the battle situation. For example, it is more desirable to destroy an enemy tank as it is moving toward the front, an interdiction mission. However, once that enemy tank is in position to shoot at one's own troops, then killing it takes priority over killing tanks to the rear that are moving up, especially from the standpoint of the troops who are facing that tank.

Both close air support and interdiction are ground support missions. Close support, by Joint Chief of Staff definition, takes place "in close proximity to friendly forces" and must be integrated with the fire and maneuver of those forces. Usually this means that the pilot must be under positive control before he is allowed to release his ordnance. Interdiction (to cut, or prohibit) attacks can take place anywhere from just beyond battle contact to hundreds of miles behind the lines, usually, beyond the established bomb line, which may be designated daily from Joint Command headquarters or more often in a fluid situation. Beyond that bomb line a pilot has discretion in using his munitions. In the very dynamic high intensity battle environment projected by Siderenko ("The Offensive," cited earlier), there will be no bomb line or clear forward edge of the battle area (FEBA). In past wars, close air support missions required a minority of tactical air missions. In the WWII European campaign close air support accounted for only 15 percent of the tactical air missions flown. However, the very rapid pace and intensity of a Warsaw Pact tank heavy mechanized force continuous offensive will be a different war, one not yet seen except as a snapshot in the Arab-Israeli 1973 October War.

The interdiction of the second and subsequent echelons of the tank and mechanized regiments and of the transport means of the volume of logistics necessary for the Soviet continuous offense may be the most effective use of NATO air resources. However, there will be an enormous demand for close air support, particularly when breakthroughs occur and the NATO artillery is fragmented, has too much to do, is hampered by uneven ammunition resupply, or cannot keep up the pace of rapidly changing combat demands.

8.3. Close Air Support/58/

The first battle of the next war will not resemble what we have come to accept as the norm -- unopposed close air support whenever we want it.

* Enemy ground-based air defenses may prevent our aircraft from orbiting or loitering over the main battle area (MBA).

* Enemy aircraft may challenge and engage close air support missions.

* Airborne and forward air controllers (FAC) may have to stand-off from enemy air defenses.

* Strike flights will probably come in low, pop-up to attack targets, and return to very low altitude for egress. Subsequent attacks will probably be at low altitude from a different direction.

The density and lethality of enemy air defenses force us to adopt new procedures to direct close air support. The airborne FAC is still necessary but must operate at low level and at a safe distance from the FEBA, perhaps as far as 15 kilometers back. He must have "eyes" in the battle area with whom he communicates and to whom he hands off the attacking aircraft for precise target identification. It is the ground FAC or Army forward observer who identifies the target. The request is then transmitted via the Air Force air request net. The observer or controller must attempt to identify enemy air defenses that could endanger the incoming aircraft, see that the pilot is warned, and assist in suppressing those defenses with artillery and other fires.

The Soviet command has long been preoccupied with organic air defense for its theater forces, for armies and units on the move and in the field.

Siderenko stated the requirement this way/59/:

"Considering the increased role of aviation and the nature of the struggle against the air enemy, under modern conditions troop air defense is given especially great significance. It will be organized through complex use in close coordination of the various PVO

/58/ FM 100-5 previously cited, p. 8-5.
/59/ "The Offensive," previously cited.

means -- fighter aviation, surface-to-air guided missiles, antiaircraft artillery, and radiotechnical means. In addition, now every chast' and podrazdeleniye must be capable of fighting the air enemy under any conditions regardless of whether they are in the zone of air defense cover of the senior commander or not. Consequently, the grouping of PVO forces and means designed to repulse enemy air attacks comprises an inalienable part of the troop formation of any scale.

In offensive combat means of troop air defense are usually used in a centralized manner with consideration for employment of surface-to-air missile complexes at the disposal of senior commanders. The basic missions of the grouping of PVO means consist of covering the main grouping of troops, reserves, and control points. The increased capabilities of air defense means facilitate the successful conduct of the attack at high rates and to a great depth."

The requirement is to saturate air space from high to low altitude, using integrated systems of conventional AA guns and surface-to-air missiles. Standard AA self-propelled vehicles include the 28-ton ZSU-57/2 and the 15-ton ZSU-23/4 (quadruple 23-mm AA guns on a PT-76 hull and controlled by B-76 radar). Surface-to-air missile systems include the aging SA-2s (the familiar Guidelines); the SA-3 (usually carried in pairs on a ZIL 157 tractor); the SA-4 (carried in pairs on a tracked transporter and with a recent version incorporating a smaller warhead); the SA-6 (grouped in threes on a PT-76 chassis); the man-portable SA-7, effective against targets flying slower than 500 knots; the SA-8, mounted on a six-wheeled amphibious vehicle and with a rotating four-round chamber complete with integral radar for surveillance and tracking (the SA-8 comprises four missiles for the launchers, plus eight reloads); and -- latest in this line of air defense systems -- the SA-9, a development of the SA-7 though with a larger warhead, increased range and mounting consisting of twin quadruple canister launchers on a BRDM-2 vehicle./60/ Warsaw Pact air defenses now provide a mobile umbrella which accompanies each echelon of the Pact Armies, including forward deployed battalions. The variety and numbers of air defense weapons accompanying a typical Warsaw Pact Army of 4 or 5 divisions are impressive.

The effectiveness of these mobile air defense weapons was seen in the Arab-Israeli October War. General Herzog/61/ stated that the Israeli ground force commanders stopped requesting sorely needed close air support because they were so appalled at aircraft losses when the Israeli pilots with consummate bravery pressed home their attacks despite the density and lethality of the air defense weapons.

/60/ The SA-8 (NATO code name GECKO) (See "SA-8: Russia's Newest Microwave Technology", Microwave Systems News, April/May, 1976, pp 131-2), may be a frequency-hopped monopulse system. The GUN DISH radar employed on the ZSU-24/4 AA vehicle has been added to the SA-9 missile system, which used an optical sight. The larger vehicle needed in place of the BRDM-2A may be derived from the BTR-60.

/61/ Chaim Herzog, "The War of Atonement," Weidenfell and Nicolson, London.

The Packard/62/ report listed six deficiencies in present close air support capability.

1 Much of the inventory of tactical aircraft would be assigned to tasks other than close air support, particularly in NATO central Europe.

2 Current aircraft/weapon combinations do not have adequate accuracy against close air support targets.

3 Present and future enemy air defense systems constitute an unparalleled threat to close air support aircraft.

4 Acquisition of small tactical targets is not adequate, especially when air defenses do not allow time to search.

5 Response times are too long for immediate (as opposed to preplanned) missions.

6 Requirements for large fixed bases increase vulnerability, decrease flexibility, and reduce responsiveness and sortie rate.

Neither the AX nor the A-7D has all-weather avionics at this time and so have only limited night and adverse weather capability.

The A-10 close air support aircraft embodies the modern Air Force close air support capability. By examining its configuration and capabilities against the threat as it has been described, implications as to doctrine for the continuous land battle can be inferred.

"Because there are no complex avionics systems on the A-10, this affects not only the cost of the aircraft, but also improves maintenance rates and sortie rates."/63/ It also means that night and adverse weather attack capability is very limited. Essentially, in a high threat Warsaw Pact air defense environment, the night is given to the enemy and so essentially is the whole day in poor weather. From January through March this is at least two-thirds of the time.

"For weapons delivery in adverse weather when visual and laser strikes cannot be used, a beacon transponder could be carried for use with the MPQ-77 blind delivery system."/64/ The MPQ-77 requires line of sight so the aircraft must be at least line of sight altitude and well within enemy surveillance and fire control radar coverage. The aircraft in its final delivery flight path has to be steady so that the MPQ-77 can project its weapon trajectory. The pilot must respond to and fly precise and steady flight path corrections. In a high threat environment, this would be the easiest kind of a target for an air defense

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/62/ Former Deputy Secretary of Defense David Packard directed a comprehensive study of the Close Air Support problems resulting in what has become known as the Packard Report.
/63/ J. Philip Geddes, "USAF Choice for the Close Air Support Role," International Defense Review, Los Angeles, 1/1974.
/64/ Previously cited reference, p. 74.

weapon. The targets against which close air support will be most necessary are moving, hard point targets -- tanks. The MPQ-77 is not suited for use against a moving target and its accuracy against a hard point target like a tank is not good enough even if the tank were not moving. It would also be a most difficult target acquisition and hand-off problem to continue to update a moving target's position to the MPQ-77 radar controller. The radiation would be detectable and jammable. Since it would also have to be close to the battle contact it would likely invite artillery or SSM fire. It has to be sited in carefully, which takes time and it could be overrun in a fast moving battle situation. Implication: The MPQ-77 is a marginal measure by which to augment night and bad weather close air support attacks of hard point, moving targets.

"Stand-off attacks using MAVERICK type missiles in good weather are a step towards safeguarding a close air support attacker. The A-10 can carry ten with a full 'look' angle for optimum release from triple ejector racks."/65/ About PGM's in the European tank threat environment, former Director of Defense Research and Engineering, Malcolm Currie, had this to say/66/: "It is not at all clear to me that some of our PGM work is all that applicable to NATO's problem in the Central Region. I want to see us do more on area munitions, rather than single target, extremely expensive, one-on-one precision-guided munitions. The German Ministry of Defense put on an Army demonstration for me about a week ago. It hit home: tank attacks in rolling terrain, forests, with tremendous haze, smoke and the confusion of that kind of battlefield is a lot different than going after a bridge in North Viet Nam." To add a sharper point to this statement, all Warsaw Pact tanks and mechanized combat vehicles can smoke. Ours cannot. The Russians also have a full complement of smoke munitions and aerosol generators.

The main antitank weapon in the A-10 is the 30-mm automatic cannon. The effectiveness of such a gun against a tank is awesome. A single German pilot in WWII killed more than 500 tanks with a specially mounted 37-mm gun. But that was in a relatively benign environment and at a time when the Germans had control of the air in Russia. If we can take control of the air and suppress the air defense weapons, the A-10 pilot using the 30-mm gun would have a turkey shoot; it would be a slaughter. "Unfortunately, while shallow dives at low speeds bring accurate bombing and strafing they also expose the attacker to the ground threat. The extent of this threat was never so vividly revealed as in the October 1973 war in the Middle East ... While it is true that A-10 survival aspects have received more attention than in any previous aircraft, at the same time vulnerability increases as speed lowers. The USAF also recognizes that even with the best countermeasures the attrition rate is likely to be high."/67/

If it were necessary because of the air defense threat to approach the target area at very low altitude, the attacking aircraft would have to pop-up and make an angle-off glide attack against a point target like

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/65/ Op. cit. p. 75.
/66/ Benjamin F. Shemmer, "Never Go Blindly Ahead," Armed Forces Journal, September 1976, p. 34.
/67/ Op cit. p 75.

a tank. It is necessary for an aircraft with a fixed gun to fly the trajectory of the bullet during the brief interval of time that the target is in gun range. When the aircraft pulls up it continues to close the target, in a typical case, tanks in company with a 23-mm quad Shilka and other battlefield mobile air defense weapons. As it closes to overfly or turn away, presenting a large belly target, the range for the air defense weapons is very close and the probability of getting hits on the A-10 is high. While the A-10 is heavily armored and designed to withstand 23-mm hits, any modern airplane is a flying wire bundle. If it gets back to base it is likely to require more than superficial repairs.

The above could be considered the optimistic scenario because the aircraft flying at low level was able to navigate precisely to the exact pull-up point so that when it rolled into its shallow glide attack the targets were right there. Navigating at low flight altitudes to a pull-up point is very difficult even in preplanned missions against a fixed target. To execute such an attack on call against a moving target is much more demanding.

The implication on the doctrine of air support of the continuous land battle may be stated this way: close air support missions in the sense of multiple passes by a heavily loaded aircraft responding to and directed by a ground or airborne forward air controller are not possible unless you have control of the local airspace; present generation precision guided munitions and stand-off weapons will not restore the situation because of the limited visibility environment and rolling wooded terrain in Europe, and because of the smoke and countermeasures of the Warsaw Pact mechanized forces; shallow glide attacks from a low-NOE approach using the 30-mm gun are probably the most survivable types of runs that can be made. However, the aircraft has to close very close to the defended tank company target and is very likely to take hits. Even if the aircraft survives because of its armor and design, battle damage repair will be extensive. The target hand-off problem from the FAC and low level navigation to an exact pull up point is a difficult problem that must be solved even to execute the attack described above. Finally, the enemy is given the night and to a large extent the time that the weather is bad. In the continuous offensive that is projected by the Warsaw Pact, and for which their tank heavy mechanized forces are equipped and configured, this is a big handicap for NATO to yield.

8.4. Night and Weather Implications

Warsaw Pact forces are fully equipped for mechanized combat at night and intend to maintain the offensive at all costs. While it is true that all Air Force aircraft are night capable and our pilots are better trained for night flying than their Warsaw Pact counterparts, effective night close air support or interdiction is not possible in a defended airspace except by relatively few aircraft like the F-111E. "During the first two weeks of the recent REFORGER exercise in which American forces were flown into Germany directly from the United States the weather was particularly bad. Air support for the ground troops was heavily committed in consequence. The only aircraft which came in every

day from England ... and which could lay down bombs with great accuracy in close support of the ground forces was the F-111."/68/

There are only 72 of these aircraft based at Upper Heyford in England. This means that a lot of time and fuel will be used going to and from target. Pilot fatigue is a vital consideration that will be discussed later. Fuel will be in critical demand, and jet aircraft flying combat profiles, use enormous quantities of fuel. The avionics systems that enable effective night attack and accurate weapon delivery -- terrain following radar, weapon delivery sensors and fire control computers -- are complex electronic equipment and require considerable maintenance. The availability of these sophisticated aircraft is inherently less than simpler aircraft and will also degrade rapidly when used constantly in the most demanding Warsaw Pact/NATO combat environment even if combat damage and losses were not a factor, and they will be. So under the best of circumstances close air support and interdiction at night and in low visibility weather conditions will be limited because there are not enough aircraft to make a significant impact. When the MRCA becomes available, the situation will improve somewhat, but unless we gain control of the air and can neutralize the large numbers of mobile gun and missile air defense weapons, the night and restricted visibility weather has been given to the Warsaw Pact forces. Either we must be able to defeat the air defense and take control of the air or have enough completely all-weather attack aircraft to make a difference./69/

A realtime surveillance and control system would be invaluable. It could exert tremendous leverage by extending the capability for effective night attack and penetration to most of the attack aircraft in NATO, with some additional investment in improved atack aircraft systems capability for the final weapon delivery.

The very limited capability for night attack of heavily defended close air support targets and interdiction targets could be augmented by stand-off weapons. However, the "first generation" stand-off weapons, like MAVERICK and WALLEYE, are clear air mass weapons. The next generation will have some improved night and bad weather capability. But it must be kept in mind that the Soviets are heavily vested in countermeasures equipment and that they particularly like basic systems -- smoke, chaff, decoys.

A great deal of dependence and investment has been made in laser designated and precision guided weapons. While they were very effective against targets in Viet Nam, the combat forces of the Warsaw Pact are a different matter. All of their tanks and mechanized combat vehicles smoke. They have developed and have in inventory aerosol (smoke) generators. The concept of using fine metal particles in aerosols and variable

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/68/ "The Combat-proven F-111 NATO's main all-weather attack aircraft," International Defense Review 3/1975.
/69/ "More than 90 percent of the close air support missions scheduled for Army Winter field exercises in Europe are aborted because of weather;" Armed Forces Journal/October 1971, p. 40.

size aerosols to "blind" target acquisition and surveillance sensors was described in the Military Herald as early as 1963.

The whole stand-off missile problem is very difficult, and by no means the least of the difficulties is the enormous expense. These missiles, by their very cost, will be limited to worthwhile targets. However, an air defense weapon system would certainly qualify if you could hit it.

The principal problem with guided weapons, night limitations aside, is that they are essentially one-on-one weapons. Even if the most optimistic kill expectations were allowed, one-on-one weapons delivered from the limited number of night and weather aircraft available are not likely to restore the situation. What would be useful in the tank and combat vehicle saturated European battlefield would be low-cost area weapons that could be distributed in large numbers and terminally home to the target. Implication: stand-off guided weapons are expensive, therefore their application and availability will be limited. They can and will be resisted by the Soviets, who already have the equipment to obscure and confuse the combat situation. They are one-on-one and will not be dominant even if the above were not the case. The battlefield in Europe is likely to resemble the Battle of Kursk in WWII where there were more than 10,000 tanks, guns, and combat vehicles involved in an appallingly confused battle; hardly a situation where a pilot, harassed by air defense weapons or even an airborne Forward Air Controller could select and designate targets. Area weapons delivered in a large numbers before the battle was closed merit serious consideration in Air Force development and doctrine.

At night in continuous combat there are the human factors considerations of endurance and fatigue. These are magnified under combat stress and are particularly critical where high skills are necessary and where there is little margin for error. This certainly applies to piloting an aircraft at night flying terrain-following altitudes. The implication here is that, under the most optimistic of circumstances in the sense of survivability and mission effectiveness, the pilot-to-seat ratio, usually about 1.5 to 1, and unprecedented sortie demands throughout the 24-hour day and over an extended period -- 30 days up to eight weeks -- would limit NATO air forces' capability to sustain air attacks against the continuous, unremitting offensive by large numbers of combat vehicles. This limitation cannot be met by doctrine or technology. Even endurance prolonging drugs could only handle a surge, but not a sustained offensive. It is a matter of numbers of trained pilots and aircraft that can keep up a high sortie rate.

Finally, all of the above -- weapons, fuel, pilots, aircraft, maintenance, and the control of operations -- are dependent on air bases. This might be the most difficult factor in the air support equation.

8.5. Air Bases

NATO air support is dependent on the availability and retention of large fixed air bases. Advanced technology aircraft, and all U.S. and NATO aircraft are that, require advanced technology maintenance and repair facilities. If these are not available, then aircraft squadrons that start with near 100 percent availability of combat aircraft would fall off quickly, probably in a few days, to a state where the aircraft, while perhaps flyable, would be ineffective as a combat force, even if both damage and losses were not a factor.

Repair of even minor damage, for example, a hole in the stressed skin of a modern jet aircraft is not a simple patch, even if systems under the skin were untouched. Modern weapon system and "black box" packed aircraft are so dense that it would be surprising to take a hit where wire bundles, hydraulic actuators, or high sophistication and precision equipment were not also damaged.

War is a desperate contingency and its modes of operation almost always opposite to efficient peacetime operations. Military aircraft operate and are maintained for most (and hopefully all) of their operationally useful lives in a peacetime environment. Even in "cold war" peace, manpower turnover and skill level are, or soon become, overriding factors. Repair facilities, special tools, individual aircraft checkout equipment, spare parts and major replacement items, cost the world. Even ground handling equipment -- refueling and defueling trucks, pressure fueling bowsers, liquid oxygen generating facilities, ordnance handling and loading equipment -- is expensive and meagerly procured because it subtracts from the budget for aircraft; already squeezed. The first items to go are usually spare parts and special equipment. These are shared by putting them at major fixed bases and this works out -- in peacetime. For every good reason of economy and optimum use of resources vital to modern aircraft operations -- skilled manpower, special tools and ground handling equipment, local contractor support, logistics, maintenance, upkeep, housekeeping, sharing airframe and "black box" technical representatives -- concentrating at a large fixed airbase and setting up a "production line" operation makes sense. In fact, it is dictated by a congressional demand for economy, by the squeeze on manpower, and by the always decreasing budget. This mode of operations, which is either forced or perhaps evolved in peacetime, is exactly opposite to the mode of operations that will be forced by the intense, continuous, and lethal character of modern warfare.

Having planned and orderly air base support comes naturally to the U.S. Air Force because in World War II, in Korea, and in Viet Nam, we owned the air and could operate any where we pleased and whenever we pleased.

The Soviets did finally control the air in the last phase of the Great Patriotic War. But most of the war he did not, and he learned to fight without air support. Even his newest aircraft are better suited to dispersed base operations than are ours. The mode of operational life that he, the Soviet aviator and soldier, will and does accept is more Spartan than would be tolerated by his U.S. counterpart. Soviet pilots,

for example, in large scale exercises at remote bases fuel and service their own aircraft.

The REFORGER concept and Tactical Air Command quick deployment packages are dependent on air bases into which to deplane and be transported farther. In fact, the air base has to be close to the air transported land combat force's prepositioned equipment or the combat capability of the REFORGER unit is nil. It may, in fact, become a transport and logistics burden. If REFORGER units had to be put off at bases far to the rear, getting them to their equipment by truck and rail transport would be a major and an immediate problem, and there would already be more major and immediate problems than could be handled.

For many reasons, while dispersed base operations with frequent shifts in locations is the desired concept of operations, or may be forced in a high mobility modern war, operation of high technology aircraft are best suited to fixed bases.

If control of the air can be gotten and maintained by driving enemy aircraft out of the air, can air base (and port) facilities upon which the defense of NATO Europe depends be relied upon? Not necessarily and not likely if the Soviets can maintain the night and adverse weather mechanized offensive for which they are trained and equipped. The major strength of U.S. and NATO is air power. Air base installations of great cost and complexity are essential to the optimal employment of that primary strength. If forced to dispersed base operations and the use of transient ad hoc runways, like the autobahn, in the manner of the Swedish concept of Viggen operations, the sortie rate and the concerted, continuous application of air power will fall off very rapidly.

Remote and contingency bases are more vulnerable to attack even by unsophisticated means. So while, dispersed base operations should get a lot of thought and attention, and that capability must be developed into a reality, it is so much in opposition to what peacetime considerations demand that dependence on fixed bases is likely to remain despite doctrinal resolutions to the contrary.

Can air bases be maintained without control of the air, that is, when enemy aircraft own the skies? No. This has never been a serious question before but it is now. The Warsaw Pact aircraft are excellent, rugged aircraft. The MIG-25 for all of its flaws is an early 1960 airplane, almost 15 years in technical age, built to challenge the cancelled B-70, yet it is usually compared to the F-15 Eagle, today's technology airplane not yet fully operational. The MIG-25 generally loses the comparision. But it has taken back the time to climb records and has a higher end speed.

As a total weapon system, both Warsaw Pact and NATO aircraft depend on air-to-air missiles. It is agreed that our missiles are superior, but the Soviets have more and they are adequate. The Soviets can bring to bear more than two and one-half times the numbers of tactical aircraft that we have and have introduced three new air-to-air missiles into

operational service -- the AA-8 Aphid, AA-7 Apex, and AA-6 Acrid./70/

Because NATO defense is so dependent on air base operations they must be protected. Can they? As targets, airfields have much to recommend them -- they are static, difficult to conceal, and much data can readily be obtained before the outbreak of hostilities.

8.5.1. The Threat/71/

The threat to NATO airfields assumes several different forms:

* Aircraft -- Each Warsaw Pact 'Front' is supported by a 'tactical army' containing six or more ground attack fighter regiments and a light bomber regiment. Given that each regiment contains approximately 40 aircraft, it may be surmised that several multiple aircraft strikes per day could be mounted against individual NATO airfields within fighter-bomber range, and it must also be assumed that even distant airfields would be targeted for attack by medium bombers. The introduction into service of such aircraft as Backfire, Fencer, and Flogger means that, henceforth, strikes are likely to be conducted in all weathers and at a low-level, and will also involve the use of stand-off weapons, plus ECM and flak-suppression missions.

* Missiles -- Warsaw Pact inventories contain a variety of tactical ballistic missiles. Typical of these is the 280-km range Scud B, for which there are reportedly 18 launchers per 'Front', and a proportion of these may be allocated to airfield targets, though probably only in a nuclear exchange.

* Ground Forces -- In addition to the threat posed by 212 advancing Warsaw Pact tank and motor rifle divisions, there are upwards of 8 airborne divisions trained in the conduct of large-scale, deep-penetration attacks and equipped with both SP artillery and tanks. Certain elements, notably the Brigada Osobova Naznacheniya (BON), or Special Duties Brigade, are specifically trained in the establishment of LZ's and the seizure of airfields.

* Sabotage -- In the period immediately before and after an outbreak of hostilities, airfields are likely to be attacked by saboteurs or 'partisans' with equipment ranging from explosives to mortars. They would in all probability receive material support from outside, and would be directly supplemented by air commandos ('Reydoviki').

/70/ "Three New Soviet Air-to-Air Missiles in Service," International Defense Review.
/71/ R. Pengilley, "Airfield Defense -- the British Approach," International Defense Review 6/1975, p. 832.

8.5.2. "Unconventional" Threats to Air Bases

What perhaps has not been overlooked but does not get enough attention is the attack of airfields by heliborne assault at night. High on the Warsaw Pact target priority list are tactical nuclear delivery means; command, control and communications facilities; headquarters; warehouse and supply depots; and airfields. All of these comprise an air base.

Siderenko, in "The Offensive"/72/ says this:

> "Taking account of the development of landing means and the changes in the character of combat operations caused by the employment of nuclear weapons, one can assume that in a future war the role of tactical airborne landings will grow, and the range of missions they perform will expand. Tactical airborne landings will be employed at any time and they will be assigned to most diverse missions: timely exploitation of results of nuclear strikes; capture and destruction of enemy means of nuclear attack, airfields, depots, and other objectives."

"The most typical podrazdeleniye for operations as a tactical airborne landing force is considered the reinforced motorized rifle battalion.

With its weaponry and technical outfitting it is capable of independently conducting prolonged combat in the enemy rear, even in the absence of means of fire support from troops operating from the front./73/

> "The darkness of night favors successful employment of tactical airborne landings, in spite of the fact that the night complicates organization of the flight, the landing of aircraft and helicopters, the drop of parachutists, and assembly and orientation of the landing party on the terrain. At night it is harder for the enemy to discover the landing party, observe the landing or drop, and counteract it. Darkness increases the probability of achieving surprise in landing a force and weakens the effects of fighter aviation, antiaircraft weapons, and the fire of enemy ground troops. All this decreases the vulnerability of the landing forces to enemy attack, hinders the fight against the forces, and as a result, increases the effectiveness of employing tactical airborne landings at night."/74/

About the strength and composition of a Soviet Airmobile unit, Turbiville/75/, a very respected student of Soviet military capabilities, has this to say:

/72/ A. A. Siderenko, "The Offensive" (A Soviet view), Moscow, 1970, pp. 102, 103.
/73/ I. S. Lyutov and P. T. Sgaydak, "Motostrelkovyy batal'on v takticheskom voxdushnom desante" (The Motorized Rifle Battalion in a Tactical Airborne Landing), Moscow, Voyenizdat, 1969, p. 13.
/74/ Siderenko, "The Offensive", previously cited, pp. 203, 204.
/75/ Graham H. Turbiville, "A Soviet View of Heliborne Assault Opera-

Soviet emphasis now rests on employing non-airborne (not specially trained) units in heliborne assault landings, specifically a tailored and reinforced Motorized Rifle Battalion (MRB). A Soviet MRB is organized into three companies of three platoons per company and three squads per platoon with combat and combat service support elements. Each company has a personnel strength of somewhat less than 100 men. Support units organic to the battalion include signal, anti-aircraft, mortar platoons, armored personnel carriers, supply, maintenance, and medical subunits. For heliborne assault operations, the MRB can be reinforced with a variety of additional support units, attached to the battalion in accord with the mission to be accomplished and the operational situation. Soviet military journals and tactical exercises have indicated that among those units most frequently assigned to MRBs taking part in heliborne landings are the 120-mm mortar battery, 122-mm howitzer battery, combat engineer platoon, ATGM platoon, chemical reconnaissance squad and specialists such as skin-divers and demolition experts. In addition to including appropriate reinforcing units, some may be deleted from the assault force. This reinforcing and tailoring of the heliborne assault elements receives a great deal of attention in Soviet training programs since determining the right composition of the assault force is essential to the accomplishment of the MRB's mission. For the objective under discussion, this force would be tailored for the attack of a fixed air base, or an easier target, the dispersed base.

A heliborne attack on northern air bases might come at night via a circuitous route at very low altitude. The cloud levels might be very low which is typical most of the year. The weather would make air attack of the helicopter formation difficult even if it were detected. The heliborne attack might present a number of decoy and deception attacks from which to choose. The attack would be heavily screened by chaff dispensers flying a self-protective S-patterns while laying the chaff./76/ Massive EW effort and jamming could be expected. At the same time, Warsaw Pact fighter aircraft with air-to-air missiles could lie back ready to move in to combat any air attack of the heliborne operation. These aircraft would fly in the same airspace as their SAM's, as was the case in the Arab-Israeli war.

The airfields could also be harassed, as could the defending NATO SAM's, by long range rocket artillery, and this would very likely be the case since the location of the HAWK's and the airfields are precisely known.

Nuclear weapons have not been discussed. However, their use against airfields, even dispersed air bases, and against nuclear storage sites is obvious. For many years the nuclear advantage, tactical and strategic, was ours. This adversely affected our perception, capabilities, tactics and doctrine for war that is not nuclear, or not immediately nuclear.

There are many military thinkers who believe that tactical nuclear war overwhelmingly favors the attacker. The Soviets do. One of the main

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tions," Military Review, October 1975.
/76/ A tactic seen in the invasion of Czechoslovakia.

reasons for the Soviet doctrine of the sustained offensive is to disrupt mobilization, to weaken the nuclear resolve of uncommited nations, to close tightly and deeply into enemy territory so that there is great confusion and considerable danger to one's own forces and the civil population in using nuclear weapons. A fierce, continuous blitzkrieg would frighten potential allies out of participation or support. Penetrating deeply as fast as possible, the accomplishment of their objectives would be so far along that a nuclear decision made too late would not restore the situation and may not be made at all.

Attacks on air bases are usually considered to be directed at major damage of the runways by deep cratering bombs and attacks against the aircraft on the airfield. Runways are not that easy to hit exactly where a deep crater would neutralize its use, and aircraft are being hangared in individual or two-plane hardened enclosures. These are very difficult to attack discretely. However, because of the importance of air bases to NATO air power, other kinds of attacks are conceivable that would be harassing and severely reduce the effectiveness of the base. The attacks on the runways could be strafing attacks by fighters simply to pock up the runways. Hitting ruts and pot holes like this at jet takeoff and landing speeds could damage the landing gear, particularly of loaded aircraft. Long-range rocket artillery could sow large numbers of anti-personnel and anti-material sub-munitions that are randomly time fuzed and are also equipped with sensitive anti-disturbance devices. Chemical munitions are well represented in Soviet and Warsaw Pact inventories. These would probably put an air base out of operation. Finally, harassment in the manner of "Bed-check Charlie" of Korean War notoriety, but this time a serious and continuous harassment effort, would not allow exhausted pilots a chance to rest or maintenance and support crews a chance either to rest or efficiently maintain and turn around the aircraft. In a sustained offensive, harassment to degrade base operations might be the most economical and effective way to weaken NATO air strength.

The most significant implication to NATO air support doctrine predicated as it is on the continued availability of air base support, is that the offensive of tank heavy forces coming at perhaps 50km a day would be upon the airfields in Germany very soon. Well before these attacks rolled over the air bases, those at the base would have to be preoccupied with packing up essential equipment to move back to bases, perhaps in England.

In summary: NATO concepts for the defense of Europe, like REFORGER and Tactical Air Command squadrons rapidly deployed from CONUS, are predicated on the availability of air bases. Rapid sortie rate, maintenance, repair, and the refueling and rearming of high technology aircraft also need high technology air base support because of the special tools and equipment and the enormous consumption rate of fuel and munitions. Dispersed base operations will help, but air operations from remote bases is less efficient, more vulnerable, will dilute protection efforts of the main base, and the sortie rate and efficiency of dispersed bases will fall off rapidly in a high paced intensive war. Besides, these satellite bases are also dependent on the main air bases to a large degree. The implication of all this in the context of continuous

combat is that the air bases are essential to Air Force doctrine and hence, from the Warsaw Pact perspective, must be eliminated, or at least hobbled. This could be accomplished by heliborne attacks at night in MRB size or larger; by direct air attack; by rocket artillery attack using chemical and random delay fuzed sub-munitions; by harassing SSM attacks to prevent rest, repair, and recuperation; and, of course, by nuclear attack should the war go that way. A very significant continuous land combat consideration is that, if the Warsaw Pact mechanized forces can move at the pace that they project, the air bases would very quickly be preoccupied with getting out of the way and moving to airfields farther back.

8.6. The Dependence on Warning Time

There is the conviction that, because of the large numbers of combat vehicles and the buildup of the huge volume of supplies and support equipment necessary for a major Warsaw Pact attack, surprise is not possible. In doctrinal manuals there are elaborate instructions for preparing intelligence templates that "will" reveal enemy intentions and indicate not only that an attack is coming but where. It is worth considering the following examples.

The Arabs surprised the best Israeli intelligence efforts; this is a matter of record. The Arab forces and mechanized equipment involved were of a lesser scale than those essential for an attack into Europe by Warsaw Pact mechanized armies. But they were very large, modern mechanized units involving more tanks than the U.S. has in Europe. The Israelis knew that there would be an attack; only the question "when?" was in doubt./77/

Consider another case, the Czechoslovakian invasion in 1968. General James H. Polk, who was then Commander in Chief of the U.S. Army in Europe and of NATO's Central Army Group, summarized it this way:

> "The U.S. and NATO commands in Europe were surprised by the timing and intensity of the Warsaw Pact invasion of Czechoslovakia. They first learned that the Pact divisions were on the move into Czechoslovakia from an Associated Press dispatch... people simply didn't think it would happen. The Soviet high command showed courage, boldness and skill. The incident illustrates the flaws in our intelligence-gathering systems as well as the tendency to misread what is available. It also displays the timidity of the National Command Center and the delayed and mild response of the NATO Council of Ministers."/78/

And yet another example/79/ by Soviet tank and mechanized forces in numbers and in magnitude of logistics on a scale required for an offensive through Europe. Operation Bagration -- the code name for the as-

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/77/ "Israeli Inquiry Hits Intelligence Unit", Herbert L. Coleman, Aviation Week and Space Technology Special Issue, Both Sides of the Suez, p. 27.

/78/ Reflections on the Czechoslovakian Invasion, 1968", General James H. Polk, U.S.A., Winter 1976, Strategic Review, pp. 30-37.

sault into Belorussia. In sixty-seven days, this operation covered 600 kilometers and resulted in the destruction of a major portion of German forces and equipment. There are many similarities between this operation and current Soviet doctrine.

During the planning phase, the Soviets did everything they could to achieve surprise. And, despite the large-scale Soviet redeployments, the German commanders continued to expect the next Soviet blow to fall in the South, between the Pripet Marshes and the Black Sea. Thus, the average frontage per German division was sixteen kilometers in Belorussia, as opposed to eight against the Ukrainian fronts. Against these overextended German divisions, the Russians concentrated 166 divisions, 31,000 guns and mortars (77-mm and higher), 5,200 tanks and self-propelled guns, and over 6,000 planes. The Russians enjoyed a superiority of 2:1 in men, 2.9:1 in guns, 4.3:1 in tanks, and 4.5:1 in planes.

Raw statistics, however, are misleading, and the above superiority figures do not tell the whole story. Hand-in-hand with strategic surprise came tactical surprise. Thus, at the six pre-planned breakthrough points the superiority was even greater. In the area of the 3d Belorussian front's two main efforts, the Russian superiority exceeded 10 to 1 in tanks and self- propelled guns and 7.7 to 1 in aircraft.

The Russians achieved their superiority at the critical points through the careful consideration given security and surprise. The fact that a large scale assault was imminent was impossible to conceal. Place and time, however, was another matter. In the attempt to cover the shift of 350,000 men and the preparations for attack, the initial planning directive ordered a security blanket from Lenningrad to the Black Sea. The Soviets misled the German command by conducting large-scale demonstrations on the 3d Ukrainian Front, plus an offensive on the Lenningrad front just days before Bagration. In order to divert German attention further, air attacks against German airfields and railroad junctions in Belorussia were based out of the Ukraine. When the blow struck, strategic and tactical surprise was complete.

This surprise was achieved at the expense of the opposing German generals who, at this point in the war, were combat experienced and who knew, or perhaps presumed they knew, their Soviet enemy.

Current Soviet military writings and doctrine stress the importance of surprise. Can it happen in Europe today? The above examples suggest the possibility.

A warning system that could look down 150 and more miles behind the Warsaw Pact borders could make surprise much more difficult to achieve. With warning, REFORGER and Tactical Air Command augmentation could be put in motion. The agony of a potential nuclear release decision could be debated within the National Security Council and discussed with the leaders of NATO countries. The implication of AWAC's, in this role,

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/79/ "Current Soviet Tactical Doctrine: A Reflection of the Past", Jospeh C. Arnold, Instructor of History at the United States Military Academy, BDM Corporation.

would be very positive in meeting the Soviet continuous offensive.

"The battlefield," said Napoleon, "is a scene of unavoidable chaos, and to win a battle a general must control those factors which contribute to his own state of chaos and exploit those affecting the enemy." The fundamental concept behind the doctrine of the continuous offensive is to break through into the enemy rear and to maintain an unrelenting pursuit, not allowing the enemy pause to regroup, and to sustain the pursuit day, night, weather, without let-up. Every effort will be made to follow Napolean's teaching and create the maximum confusion and chaos. Should the war go nuclear, virtually every study of tactical nuclear war in Europe concludes that command and control will be critical, most agree that it will be lost.

An airborne control system that would be able to keep track of and sort out the aircraft in the air, which could number several thousand, will be essential in an intense war in Europe. Ground environment control systems will be under great pressure, have a much narrower look, and, along the main attack axes, may be rolled up. An airborne system can fill gaps quickly and, if necessary, take on the entire responsibility. It has the greater area coverage and should be able to control aircraft against penetrations at any altitude.

Most important, will be the requirement to look into Soviet tactical air base activity because these bases will be drawn up close to the Soviet Army units they support.

An important airborne realtime surveillance system capability will be the detection of heliborne assault operations. The convergence of transport helicopters and the loading of troops and equipment takes place quickly. The goal is twenty minutes. So a helicopter assembly area is a transient target that must be detected and recognized in real time.

The airborne control system could be used, if the capability were developed, in the role of attack aircraft control especially at night and in low visibility weather. The difficulties first in detecting targets -- tank formations and mechanized infantry combat vehicles -- then navigating at low flight altitudes to an exact pullup point for a quick-in, quick-out attack by on-station close air support aircraft has been discussed.

The most important requirement of an airborne control system in the continuous land battle will be to retain a realtime awareness of the battlefield situation which will be of unprecedented intensity and fluidity, one without established battle lines, where mechanized forces deep in friendly territory are as likely to be enemy as friendly. It can transmit the battle situation by data link to those ground commanders in position to react.

Command, control and communications within NATO has been a recognized weakness. Getting a decision from higher level NATO commanders even in exercises has been difficult. In the war that is projected by the Soviet's continuous offensive, delays in command decision, confusion in the control of forces, and even a short lapse in awareness of the

battle situation could be very damaging. The AWAC's, or systems capable of the AWAC's function, will have a major impact on Air Force doctrine for the continuous land battles.

8.7. Summary; Some Concepts

8.7.1. Problem Elements

Some of the fundamental problems of Air Support in the continuous land combat in Europe are:

* The organic air defense weapons like the ZSU23-4, SA-6, SA-8, and SA-9 that move with and are part of the mechanized combat force tactical formations.

* Dependence on fixed air bases for NATO concepts for the defense of Europe and for optimum sortie rate and all support functions -- fuel, munitions, control of operations, repair, rest.

* Limited capability for ground attack at night and in bad weather primarily because of the relatively few aircraft fully equipped for all-weather attack of defended targets.

* Real time surveillance and target acquisition of major targets and target formation and the hand-off of this information to attack aircraft.

* A means for the navigation or direction (in the manner of the control of air intercept) of attack aircraft to a pull-up point for an optimum survivability attack, to the target, then back to a coordinated rendezvous via random safe routes (not over another air defense weapon).

* Means for maintaining the air and ground picture, then for using that data -- handling it off -- to ground commanders, to air defense coordination centers, and to air control centers.

* Maintaining a high and sustained sortie rate that will be demanded by the intensity and continuous character of the offensive. This is in turn dependent on human factors considerations, fatigue of high skill personnel, pilot to seat ratio, availability of air base support, and the maintainability of high technology aircraft.

* Control of the air. This is primarily a problem of being outnumbered, of the dominant role of the missile in air combat, and again, the availability of air bases.

* Clear air mass dependence of most precision guided munitions and their one-on-one character.

8.7.2. Air Defense Weapons

If the organic air defense weapons of the Soviet mechanized forces can be defeated and control of the air taken from Soviet aircraft, the continuous offensive of the Warsaw Pact forces can be defeated. This can be done within the framework of present air and ground force doctrine and organization even though these are conventional and are predicated on the traditional, last war intermittent nature of ground and air warfare.

If attack aircraft can run free, even if they operate only in daylight hours and rest at night, they could kill tanks and mechanized infantry combat vehicles in wholesale numbers and put following echelons in shambles. This is, of course, the reason for Soviet preoccupation with air defense and electronic warfare in the first place.

Jamming and other electronic countermeasures are obvious means and have a great deal of emphasis. It is not a sure and comfortable method (for the pilot). Both the Egyptians and the Israelis agree that EW measures in the October 1973 war were not effective and were not worth the effort and cost: "Although ECM played a major role in the final successful SAM suppression operations in the October War, Israeli Air Force (IAF) professes to be dubious about their value."/80/

"Airborne electronic countermeasures (ECM) are not worth their high cost because of their limited value in modern combat." [Lt. Gen. Mohamed Ali Fahmy, Egyptian Armed Forces Chief of Staff] "General Fahmy noted that Israeli Air Force commanders agreed with him."/81/

"The ground-oriented element in IDF has already opted to use the LTV Lance 45-mile-range with a cluster bomb unit, particularly against "fixed" SAM installations.

Anti-radiation missiles to home on EM radiation are easily defeated. Soviet SAM systems are already equipped with optical backup, frequency agility, offset radiators, and shut-down and deception tactics.

The IAF is leaning toward the use of mini-RPVs as decoys and to exhaust the SAM (and gun) batteries re-fire capabilities.

Lance SSMs are very expensive, consequently in short supply. They will probably be reserved for the nuclear mission. Distributed submunitions are also very chancy. The probability of getting a hit is surprisingly low even when large numbers of bomblets are put randomly on the target area. A better solution is a terminally guided sub-munition which, when distributed in large numbers over the target area, would home to individual targets if such a munition could be developed at an affordable cost./82/ Delivery could be made by SSM, artillery, RPV, and

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/80/ "Both Sides of the Suez," Aviation Week and Space Technology, p. 10.
/81/ Op. cit., p. 24.
/82/ Keynote address, Malcolm R. Currie, Close Air Support Symposium, Langley AFB, Virginia, October 6, 1976.

tactical aircraft. Zero-length launched basic (cheap) "RPV"-type vehicles would put the weapon and delivery means into the hands of the ground commander. The biggest advantage to this kind of area weapon is that it is a one-on-many weapon and overcomes the one-on-one limitations of stand-off missiles.

It would be useful to the terminally guided sub-munitions, as well as to other homing weapon concepts, to have an enhanced target signature. Present systems use inherent characteristics of military machines like heat. Natural vehicle emission in X, or Ku band, or other bands of the EM spectrum might also be considered. A vehicle would look like a black hole to such a sensor. Inherent target emissions might be augmented by a transmitter or flare rich in the homing frequency. The guidance systems in each missile could be receiver only and as basic (cheap) as possible and home on the reflected energy. Chemical means of augmentation -- "target marking" -- may have value. Is there a chemical compound that could be put in aerosol form or air suspension (smoke) on the large numbers of combat vehicles that would react with the metal or the lubricant, rubber, and other fundamental material and "mark" it for a munition capable of seeking the emissions caused by the reaction.

An alternate approach to the ARM might consider a hybrid missile RPV that could be pre-progammed or "on command", having covered the major enroute part of the trajectory to the air defense radar as a missile, decelerate and assume an RPV configuration for the distribution of chaff, cut within the RPV to the radiator's frequency. The chaff would be laid on top or in the immediate area of the air defense radar so as to extract energy from the strong out-going pulse as well as the weak return echo.

An opaque one way aerosol (smoke screen) put on the air defense weapon by RPV, artillery, or SSM might be possible. The trick would be to have the means in the attack aircraft, say thermal imaging, Ku band radar, other, to see through the "smoke" -- metal particles in suspension, aerosol, chaff, or combination. However, the obscuration would be opaque to the air defense target acquisition means.

Stand-off weapons which are line-of-sight and clear air mass dependent will not be useful in the European environment against on enemy so well equipped in basic countermeasures as are the Soviets. However, next generation night and low-visibility capable PGM's would be useful if the air defense weapons could be selected out of the tank-saturated ground environment, perhaps by some real time target acquisition systems.

8.7.3. Real Time Target Acquisition and Surveillance Systems

There is agreement that the battlefield in Europe will soon become extremely confused. There will be no Forward Edge of the Battle Area (FEBA), or bomb line, or clear demarcation between friendly and enemy units.

Real time surveillance and target acquisition systems that could hand-off the information to command and control facilities for action will be critical. Most reconnaissance systems are capable of fine grain

detail, too detailed for ready understanding or use, and in a format that requires extensive skilled processing and which gets the information to the commander too late.

The AWACs, is an expensive self-contained system. A modular sensor carrying RPV linked by dish-to-dish microwave to the command and control facility would be useful. The target acquisition package might include a synergistic family of sensors: IR, side looking synthetic aperture radar, communications and jamming detection (whose location could be accurately determined by integration of the bearing change as the RPV moved along its flight path), COMINT and SIGINT detectors. The objective would be real-time detection of major systems and target arrays. In the command center information could be processed by computer using self-learning and advanced programming artificial intelligence techniques. Major targets recognized within the computer could be displayed in symbol form to the commander on a situation projection display system.

Transponder-equipped low-flying attack aircraft could then be directed to the target by attack aircraft directors in the command center using methods similar to those used in controlling airborne interceptors. The aircraft position, including encoded altitude and airspeed might be sent back by directional antenna via the sensor carrying RPV data link.

8.7.4. Dispersed Base Operations

A major limitation in dispersed base operations is in the repair, maintenance, and servicing of advanced technology aircraft. To do this efficiently, or at all, depends on advanced technology check-out and support equipment.

Rapid developments in microprocessor technology and solid state electronics suggest the feasibility, not only of redundant systems and components in aircraft "black boxes", but also self-contained test and check-out equipment. Relatively few years ago, and indeed today, these complex advanced technology test and check-out systems were (or are) housed in large consoles or ground support vehicles that couple into the aircraft by an umbilical connector. Microprocessor and integrated electronics technology allows extremely complex functions to be performed with great reliability, light weight, low power, hence low cooling requirements, and at low cost once R&D is written off. R&D costs will be major, but broad applicability even to ground vehicle maintenance would justify the cost pro-rated.

The same techniques could be applied to increasing mission effectiveness survivability of aircraft (and advanced combat vehicles) using microprocessors, multiplexing, packet information techniques for transmitting, control and air data along redundant power conduits. These power cables could be designed for quick isolation in the event of damage. The "Achilles heel" of modern aircraft (and advanced weapon systems, combat vehicles) is the wire bundles. The concept described is well suited to fly-by-wire systems to which modern aircraft are going.

A systems approach to all aspects of dispersed base operations

could be taken. For example, ordnance is too heavy to be man handled. Specialized handling equipment is limited in numbers. Munitions could include their own simple cable and reel loading mechanism which would be driven by hand crank on portable electrical drive motor. Similar considerations could be applied to other aspects of servicing, repair, refuel and rearm.

Not the least of the dispersed problems will be instrument approach systems, such as portable microwave landing systems. These are in development but a truly portable, low cost system for dispersed base appears necessary, not one that is universally applicable.

8.8. Summary

The configuration, doctrine, equipment, and procedures of the U.S. and NATO air forces in Europe have evolved under the influence of past combat experience where we always had control of the air, the constraints of peacetime attitudes and budgets, and assumptions upon which the defense of NATO Europe is predicated. These are implicit in concepts like REFORGER, in the posture and training of NATO air and land forces, and in doctrine and procedures that are a carryover from when the U.S. had a dominant nuclear superiority. These assumptions include ample warning time, the availability of air bases and port facilities, and control of the air.

The interdiction of the second and subsequent echelons and of the flow of the enormous amount of supplies that are essential to a continuous offensive will be the most effective use of the limited NATO air resources. However, while close air support missions were a small fraction of the air effort in past wars, in the confused battle which will be characterized by deep, high speed armored thrusts, no front line demarcation, and sudden and acute changes in the battle situation, the capability for rapid and wide ranging response of CAS aircraft will be essential. Tough decisions on allocation of air support resources will be necessary.

NATO and U.S. aircraft have only a limited night capability. Close air support and interdiction at night and in poor weather will rest on aircraft like the F-111E, a very small fraction of aircraft resources.

The requirement to operate day and night will rapidly exhaust high skill maintenance and operational personnel, particularly pilots, even if battle losses and damage were not a factor and these will be of an unprecedented magnitude briefly seen in the Arab-Israeli 1973 war.

Driving enemy aircraft out of air may not be so sure. We have acknowledged superiority in pilot experience, training, and capability. But modern Soviet aircraft are excellent machines. They have a significant numerical advantage, and air combat has become largely dominated by air-to-air and surface-to-air missiles. Soviet missiles have been deadly effective in combat.

Close air support doctrine, which is embodied in the A-10, enables retail delivery of ordnance in repeated attacks on demand by Forward Air

Controllers, from heavily loaded on-station CAS aircraft. This will not be workable against Soviet mechanized forces defended by mobile gun and missile air defense weapons in numbers and lethality never seen before. Because of avionics and weapon delivery limitations by CAS aircraft, night and periods of low visibility, prevalent in Europe two-thirds of the time, are essentially conceded to the enemies' mechanized forces.

Most critical to continuous combat is the dependence on air bases for sustaining operations, the deployment of REFORGER units, Tactical Air Command squadron augmentation, and for unloading and further delivery of supplies. The threat to these bases, since they are key to NATO defense, will range from conventional air attacks to assault at night by heliborne forces in battalion strength and larger. Harassing attacks by SSM's and aircraft can also impair air base effectiveness.

A real-time surveillance and control system that is capable of the AWAC's function is essential to the defense of NATO. It can provide more warning time, control and direct air superiority aircraft, maintain awareness of the land battle situation, enable and enhance command and control of air and ground forces, and extend the night and weather capability of CAS and interdiction aircraft by locating targets in real time and by directing and controlling these aircraft in their low altitude approach and attack.

9. Logistics, Maintenance, and Other Combat Support

9.1. Continuity in the Support Functions

Continuous combat requires continuity in every essential element of combat support and service support and not simply in the combat function. While this is obvious, combat service support functions -- logistics, maintenance, medical -- are where peacetime pressures, influences, and attitudes influence adoption of administrative procedures and methods as well as equipment that is best suited for peacetime efficiency. These are usually opposite to the "wasteful", redundant, and throwaway requirements of combat. The modern concept of continuous, lethal, furiously paced and fluid combat exaggerates the extremes between peace and war modes of operation. A most vital consideration is that there will not be the time to transition from "production line" maintenance, overhaul and rear base concepts of operation to the forward, highly mobile, tailored to the situation kind of operations demanded by continuous combat.

In the sections that follow, the subject of combat service support is discussed largely through the mechanism of Soviet procedures, concepts, equipment, field tests and exercises as they ave been described in their military literature.

It is not intended to suggest that what is presented are established capabilities of the Warsaw Pact forces in the threat assessment sense, or that what they have done (or are thinking) is the best or the recommended way for us to proceed. But the Soviet's have been studying and writing and working hard toward the capability for continuous, intense, rapidly paced mechanized land combat and the staggering suport problems to keep up with the voracious equipment and logistics appetite of this kind of warfare. Their ideas and concepts are interesting, well considered, well tried, and represent a valuable body of military thought. Therefore, they are presented here to provide, through substance and example, a departure point for our own concepts and developments.

9.2. Soviet Logistic Support

9.2.1. Presumed Weakness

The logistic capability to support Soviet combat forces in even a short war has been assessed by some observers as marginal. Among the potential problems cited have been the Soviet reliance on logistic personnel and vehicles mobilized from the civilian economy, the difficulties in maintaining open lines of communication (LOCs) from the U.S.S.R., the high ratio of combat equipment and troops to support elements in Soviet divisions and an apparent rigid assumption on the part of Soviet planners that a future war in Europe, nuclear or conventional, will be quickly concluded.

There has been an extensive investment by the Soviets in combat support and staying power, regarded as a major weakness. Soviet improvements range from new and varied types of tactical command vehicles,

an increase in the number of petrol bowsers and cargo-carrying trucks, to the development of considerable resources in tank-transporter regiments with some 2,000 transporters available to move the equivalent of five tank divisions by road and thus reduce dependence on rails.

Stocks have been much increased: GSFG now holds ammunition for 37 days and fuel (petrol, oil, and lubricants) for 16, without drawing on strategic stocks in East Germany itself. Soviet assault bridging equipment has always been second to none. Both tank divisions and MRDs have engineer battalions (26 officers and 427 men in an MRD, 431 men in the tank division engineering battalion), operating vehicle launched bridges, pontoon bridge carriers and heavy amphibious ferries, together with cargo carriers, mine-clearing equipment, bulldozers and excavators (including trench-digging machines). At Front and Army level there are additional engineering assets, including larger bridging stocks and special assault pioneer (river-crossing) and pontoon bridging battalions. Additional pontoon bridging battalions -- the 4th, 5th, and 36th and 40th Battalions -- have been assigned to Soviet armies in GSFG, while river-crossing battalions have been reinforced with heavy amphibious vehicles and GSP ferries./83/

Military supply stockpiles are designated as emergency reserves, mobilization reserves, strategic reserves and state reserves. Both emergency and mobilization reserves are intended for use in the initial stage of war. Emergency reserves are located with deployed ground force formations (divisions, armies, fronts/groups of forces military districts) and are to be used for the immediate conduct of military operations. Mobilization reserves are to be used to replace combat losses in the course of theater operations and are established on the basis of the huge losses the Soviets expect in a nuclear war. This would seem to be something of a bonus in the event of a conventional conflict where losses would be less. Strategic reserves consist of those material items placed under the control of the General Staff and are not envisioned for early use. State reserves comprise those resources over and above the stockpiles under military control.

9.2.2. Maneuver Forces/84/

The maneuver elements comprise armored fighting vehicles, mechanized infantry combat vehicles and reconnaissance vehicles. The manpower level in Groups of Soviet Forces abroad has increased by some 100,000 over the past five years. None of this has gone to raising new formations within the order of battle; rather, existing formations have been "packed" with more weapons and greater resources directed to Front and Army level.

The motorized rifle division now consists of some 13,500 officers and men, with 266 tanks, 22 PT-76 amphibious reconnaissance light tanks, 320 infantry combat vehicles (95 modern BMPs and the remainder

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/83/ Trends in the Soviet Combined Arms Concept," John Erickson, Strategic Review.
/84/ "Trends in the Soviet Combined Arms Concept," John Erickson, Strategic Review.

BTR-60PBs) and almost 200 BRDM reconnaissance scout cars. The artillery component is made up of a FROG battalion, 72 D-30 122-mm guns (with self-propelled complements of 6 122-mm and 18 152-mm guns), 54 120-mm mortars, 18 BM-21 MRLs, 18 T-12 100-mm antitank guns, an antiaircraft regiment with 30 S-60 (57-mm) guns, 18 ZSU-23/2 and 16 ZSU-23/4 plus 6 ZSU-57/2s, supplemented by 16 SA-9s and 128 SA-7s. Among the support are 32 MTU-55 and TMM vehicle launched bridges, 4 GSP ferries and 18 PMP.

The Soviet tank division has a manpower strength of 11,000 officers and men, with 325 tanks and 22 PT-76 light tanks, 152 BMP (mixed with the older BTR-50P) and almost 200 BRDMs. The artillery component now includes the 122-mm SP and 152-mm SP guns (6 and 18 respectively), 36 122-mm guns, 4 FROG, 18 120-mm mortars, 18 BM-21 multiple rocket launchers, an antiair regiment with 30 S-60s plus 86 SA-7 and 16 SA-9, 6 ZSU-23/2, 16 ZSU-23/4 and 14 ZSU-57/2. Engineer/high speed bridging support is afforded by 46 MTU-55 and TMM, 6 full ferry GSP and PMP. Like the motorized rifle division, the tank division has between 3,000-4,000 vehicles, but this is the least significant of the comparisons. What is immediately obvious is the great increase in the tank strength of the motorized rifle division -- the MRD is made up of three motorized rifle regiments (each with 40 T-62 tanks and over 100 infantry combat vehicles), one tank regiment (with 95 T-62 battle tanks) and the recent addition of an independent tank battalion (with 51 T-62 tanks). At the same time the MRD disposes of two types of regiments, those made up of the more modern BMPs and others with BTR-60PBs, with the BMP-equipped regiments also incorporating the new self-propelled guns (122-mm and 152-mm). Meanwhile the tank regiments in Soviet tank divisions in GSFG (Group of Soviet Forces/Germany) have been taking a motorized rifle company into their ranks, in addition to the motorized rifle regiment attached to the division as a whole. The addition of that MR company gives the Soviet tank regiment commander ten BMP's.

9.2.3. Logistic System; Divisional Rear Services and the "Delivery Forward" Concept

The streamlining of Soviet divisional rear service units, while receiving a great deal of attention in the late 1950s and early 1960s, had, in fact, begun during the last years of World War II in response to the growing mobility of divisional combat units, and their faster rates of advance. Rear service elements were decreased in size with particular emphasis placed on upgrading the mobility of ammuition supply, fuel supply and maintenance elements. When speaking of this trend in World War II divisions, a recent Soviet publication stated the following:

> "The trend in the organization of formations and units was a desire to make them more compact, maneuverable, and better controlled. The size of the line, support and maintenance subunits was reduced, while the firepower and striking force rose."

The rear service units now found in Soviet motorized rifle and tank divisions are the result of many years' emphasis on mobility, a process given impetus by the rapid rates of advance envisioned in a nuclear campaign, but conditioned over the last 10 years by the realization that

divisions may well have to fight throughout operations with conventional weapons only.

The logistic makeup of motorized rifle and tank divisions is nearly identical, with each division having these principal logistic units: a motor transport battalion for the transport of ammunition, fuel and general purpose cargo; a mobile maintenance battalion with specialized shop vans designed to repair armor, soft-skin vehicles, small arms and technical equipment as close to the front lines as possible; a medical battalion; mobile food preparation elements; and a depot system stocking required supply items. Each line regiment has organic motor transport and maintenance companies, as well as medical and mobile food preparation elements. Transport, maintenance, medical and food distribution assets are found also at battalion level. These division rear service units are smaller in size than those found in some Western divisions and are designed to keep pace with the fastest Soviet advances while reducing complex organizational and command and control problems in the fluid battlefield situations the Soviets expect to encounter. In Soviet divisions, logistics resources are not used for what are considered nonessentials, but are designated to deliver material in accord with a strictly adhered-to supply priority of ammunition first, followed by petroleum, oils and lubricants (POL), technical suplies, rations and clothing. In this way, the Soviets believe that supplies necessary for the accomplishment of the division's mission can be delivered in a timely manner for the duration of the division's role in the operation though the comfort of the troop is certainly a secondary consideration. Reserves of critical supply items over and above those items necessary for the accomplishment of the division's mission are maintained at each organizational level within the division and can be used only with the permission of the respective unit commanders. So the Soviets, in order to have a mobile, easily handled logistic tail, have cut the size of division rear service units, instituted a strict order of supply priorities and, while allowing supply leeway in the accomplishment of divisional missions, have reduced to some extent the staying power of a divisions.

The Soviets operate under the "delivery forward" principle in which higher headquarters directly supply and service the next two lower headquarters using their own organized logistic assets. Thus, a Soviet front (army group) would be required to transport material to army and division level using front transport. An army would supply subordinate divisions and regiments, and so on. In this manner, the tactical logistic system (division and below) is linked to the operational system (front and army) and up to the central support network spreading both across the Soviet Union and over the theater of operations. Since the burden of supplying and maintaining engaged divisions falls upon higher headquarters, Soviet planners have put the bulk of their logistic resources at army and front levels. The advantages of the system are obvious -- the highly mobile divisions are free to operate without being encumbered by slow-moving supply shuttles of organic vehicles, while the logistic backup is maintained at army and front. At army level, for example, there will be found one or more motor transport regiments which, with perhaps 1,000 plus trucks per regiment, can be used to support subordinate divisions generally or be used to augment divisional

resources by the attachment of designated army motor transport elements to the divisional motor transport battalion. At front level, there will be one or more motor transport brigades in support of subordinate armies and their divisions. In World War II, for example, the Transbaikalia front in the Soviet Far East had under front subordination one motor transport brigade, two motor transport regiments, and 10 independent motor transport battalions -- this being in addition to the transport found within the subordinate armies and divisions. The motor transport picture at army and front is paralleled by other logistic formations to include sizable maintenance resources, LOC repair and construction units (road construction and railway troops) and tactical pipeline construction units.

Overall, the Soviets have designed a logistic system that meets the requirements of their tactical doctrine for a totally mobile division, but which also contains a considerably greater number of logistic assets than would be apparent by looking at divisions in isolation. With the major concentration of rear service resources at front and army levels, the flexibility exists to employ these resources in a variety of contingencies, from supporting combat forces in a fast-moving nuclear war to maintaining line divisions in a longer conventional conflict through general support or through unit attachments.

9.2.4. Motor Transport

It is acknowledged by Soviet logisticians that motor transport will be the principal means of delivering supplies from front level down. In a nuclear war, motor transport will assume particular importance where destruction to railroads in the combat zones will preclude any kind of reliable delivery to frontline units by rail. Also cited is the greater flexibility of motor transport, a necessity when one considers that a front motor transport unit may directly supply an engaged division.

The standard Soviet general purpose cargo carrier is the URAL375 truck, judged by Western experts to be an outstanding vehicle. Possessing all-wheel drive (6X6), it has an off-road capability well suited to frontline ammunition deliveries. With a rated dirt-road cargo lift of 4.5 metric tons, it is judged capable of lifting perhaps 75 percent again as much when operating on paved surfaces.

Of major importance, when considering the lift capabilities of Soviet motor transport units, is the widespread use of cargo and fuel trailers, a practice that can more than double the lift potential of the truck. Thus, a URAL375 fuel truck and trailer unit has a total lift capability of 9,200 liters, while a URAL375 cargo truck/trailer unit could transport some 9.5 metric tons on dirt roads. Aside from greatly increasing logistic lift, maintenance requirements are also much less than if additional trucks were used in lieu of trailers.

With the development and serial production of the MAZ-537 tank transport semitrailer, the Soviets are now estimated to have semitrailers sufficient for a simultaneous lift of five tank divisions.

9.2.5. Tactical Pipeline Construction

The Soviets believe that fuel and lubricant requirements could amount to about 50 percent of the total supply quantities required. "Military Strategy" indicated that this could equal 25,000 tons a day for a front offensive operation. This figure was also quoted in an East German military publication which added that about 300,000 tons would be required for an entire front operation. While motor transport will play a major role in transporting POL, Soviet planners also will rely heavily on tactical pipelines to move fuel forward over longer distances. Pipeline construction brigades of several battalions are assigned to Soviet fronts to construct one or two tactical pipelines in the direction of the main effort for support of the ground forces. Additional pipelines are constructed for the tactical air army. In the rear service exercise Niemen, pipeline reportedly was laid over many hundreds of kilometers with 24 fuel trucks being refilled simultaneously at one terminal. One type of pipeline employed by the Soviets (Type 15) can supply 2000 tons of fuel a day. Overall, the Soviets expect a great deal from their pipeline construction units, and they have received frequent praise in the Soviet military press.

9.2.6. Maintaining Lines of Communication

Railway and road construction units have been quite active in Soviet and Pact exercises over the last decade. Extensive damage (to railways in particular) is expected both in the interior of the Soviet Union and throughout the forward area as well. Many exercises include a phase focusing on the rapid repair of damaged rail lines, bridges and roads under simulated nuclear conditions.

The Soviets claim that a floating railway bridge can be put up in several hours. Considerable publicity was given to the construction of such a bridge by Soviet Railway Troops in the 1967 exercise Dneiper.

9.2.7. Air Resupply

The magnitude of Soviet operations against NATO, as envisioned by most Western military observers, will mean that even the most ambitious aerial resupply efforts by Soviet cargo aircraft will make little dent in the overall requirements of several fronts. Assuming that Soviet ammunition consumption will be about equal to that of U.S. forces, it would require 25 flights of the largest Soviet cargo aircraft (the An-22) to meet the ammunition needs alone of a tank division engaged in high-intensity combat for one day. In addition, An-12 and AN-22 aircraft (the principal medium and heavy air cargo carriers), apparently are designated to be employed extensively in airborne operations that would seem to have the first priority for aircraft allocations. All of this considered, however, the performance of Soviet Military Transport Aviation in the 1973 October War was perceived as an impressive airlift capability which, in the right situation could make a significant contribution to filling some supply and equipment requirements. These would in all likelihood include troop replacements (720 unequipped troops per An-22) and critical equipment items. For example, An-22s have demonstrated for the public their capability to transport Frog nuclear-

capable tactical rockets, Scud nuclear-capable tactical missiles and the Ganef SA4 air defense missile system. Helicopters are frequently used at the tactical level to transport ammunition and POL in exercises and would certainly be used in such a role in wartime. Generaly speaking, however, most consumable supplies will be transported by motor transport and pipeline at front level and below, while rail will continue to play a major part in moving supplies from central support facilities in the USSR.

9.2.8. Crossing Water Barriers/85/

Night combat and river crossing operations are regarded as "special operations" in the U.S. Army. Soviet doctrine insists they are routine components of modern combat. Soviet planners have put their equipment where their doctrine is, and no army approaches them in bridging equipment. They have an advantage in the conduct of military operations at night as well.

The Soviets can bridge a river such as the Rhine at multiple points, erecting pontoon bridging (PMP) in times down to a half hour, whereas the U.S. needs six hours to emplace its standard Bailey Bridge. All Soviet APCs with the exception of older BTR-152 and BTR-40 models are amphibious. The PT-76 light-tank, the BTR-50 (tracked) and BTR-60 (wheeled) APCs have hydrojet propulsion in the water. With the apparent retrofitting of T-54 models, it appears that all modern Soviet main battle tanks can snorkel across water barriers up to 5.5 meters in depth. Only the West German Leopard has such a capability. Not only are Soviet combat bridging stocks large, but they have also developed rear echelon and logistical bridging, including the NZhM-56 pontoon set which will bear simultaneously rail and wheeled traffic.

9.2.9. Mobilization of Rear Service Elements

Virtually every major Soviet and Warsaw Pact exercise, while mainly publicizing tactical play by ground units, is a rear service exercise as well, Dnieper in 1967, Dvina in 1970, Yug in 1971 and Shield in 1973 all featured heavy participation by rear service units. Small unit training for logistic personnel goes on year round, paralleling that of other ground force arms in the Soviet training program. Soviet military literature, most notably Rear and Supply of the Soviet Armed Forces is replete with accounts of training undertaken by motor transport, maintenance, medical and other logistic support units. It would be reasonably assumed, therefore, that active duty rear service units are as well-trained in their specialties as are the combat arms in theirs. But, in addition to active duty combat and rear service formations, there are those personnel and equipment items that would be mobilized in wartime. The Soviets have indicated that the most extensive mobilization will occur in the ground forces. Aside from those troops designated to fill up divisions at less than full strength, mobilization will consist in large measure of the callup of reserve transport, construction, medical and maintenance personnel, as well as their equipment. Reservists are those

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/85/ "Soviet Tactical Doctrine and Capabilities and NATO's Strategic Defense," Captain Eugene D. Betit, U.S.A., Strategic Review.

individuals who have completed regular military service and who are obligated under Soviet law to undergo periodic military training (the strict enforcement of which is debatable). No reserve units, as such, are maintained, and with some exceptions, most reservists seem destined to augment understrength units already in being. The Soviets claim a rapid, simplified mobilization system. Perhaps the best illustration of what this mobilization will entail in the area of logistics was presented in the major rear service exercise, Niemen, taking place in July and August 1968, just prior to, and in preparation for, the Soviet invasion of Czechoslovakia.

Most of the reservists, who have had previous military experience, will be assigned to military specialties requiring the same skills as those they employed in civilian life. The mobilization system has worked smoothly in exercises; it should be recalled that Niemen was something more than an exercise, preparing as it did lines of communication for the invasion of Czechoslovakia. The mobilization system is a real Soviet strength, enabling the USSR to establish an impressive wartime logistic network, one which would be difficult or impossible for any country to maintain in peacetime.

The emphasis given logistic matters in the military press and exercises, as well as the continued upgrading of transport, maintnenance and material-handling equipment and procedures, is a reflection of the Soviet recognition that inadequate logistic support is a frequent limiting factor in the successful conduct of combat operations.

9.3. Combat Service Support Doctrine of the U.S.

The service support doctrine as it applies to ammunition resupply is representative. In order to sustain operations, ammunition needs for specific periods are submitted by types as Required Supply Rates. Variables are accounted for by having each commander announce a Controlled Supply Rate. Successful resupply depends on:

* A smooth flow of ammunition supplies from CONUS to the units that support the weapon system.

* Estimates of requirements based on usage, experience, and type of combat anticipated.

* The ability of combat service support commanders to respond to changing situations.

Rather than detail the procedures and the organizations, which would have no useful point since they are published and distributed widely, some combat support considerations in the context of the continuous combat environment of a war in Europe are presented.

The primary strength of U.S. and NATO is advanced technology. There is agreement that in computer-based data management systems, automatic data processing, high-speed automatic data transfer, and communication systems, we lead the world. These are at the heart of keeping an account of materials, supplies, and of the complex and enormous detail required

in logistics, maintenance and supply support. The data has been developed, based on combat experience and expected demand.

The enormous and unprecedented consumption of supplies and loss of equipment and material because of the lethality of modern weapons was seen in the Arab-Israeli war. Since only the Arabs were equipped for night land combat and did not have the doctrine to exploit it, even the usage data of the October 1973 will be eclipsed by a continuous combat environment in Europe. To the point, the rate of expenditure of supplies by class and volume has no basis in experience and so must be developed by analysis and by the use of such methods as war gaming and combat simulation. For example, use of small arms ammunition at night in a static infantry style war is extravagent. Most ammunition is fired for its "suppressive" effect rather than as aimed fired. If, as the Soviets maintain in their doctrine, troops will fight mounted, the meeting engagement from march formations will be the expected mode of combat, and dismounted combat will be the exception. How will this affect effect small arms usage rate; stockage; resupply; other ammunition and resupply; the feeding of troops; bathing; laundry; and basic amenities? What is the expected use rate of illuminating rounds which were used extensively in Korea and Viet Nam? If both sides are equipped with devices that permit effective operations at night and in low ambient light levels, will illuminating rounds usage go down?

A tactical nuclear war has never been fought, let alone a continuous offensive nuclear war such as that projected in Soviet doctrine. Both U.S. and the Soviet talk openly about the tactical nuclear land battle. In point of fact, the Soviets are better prepared for the actualities of nuclear war than are we. It is only recently that their professional military documents admit to a conventional war contingency. Our stated doctrine is based on flexible response: maximum use of conventional forces, then if necessary, tactical nuclear firepower, and finally strategic nuclear war. How does this affect combat service support, resupply, and munitions, conventional and otherwise. Is this in the logistics and resupply data base? Should it be?

While there will be increased dependence on air transportation and on air lines of communications, a major war will, as projected in current doctrine, depend on sea lanes. Eight weeks has been estimated to be the time required to get sea lane supply lines flowing. If the Soviets can implement their continuous offensive, the war in Europe will either be nuclear, or over and done, or both, unless the capability for continuous combat in all of it aspects, including and especially, combat service support, is gotten in hand.

FM 100-5 states that forward deployed forces, and those reinforcements immediately available, must be prepared to accomplish their missions with the resources on hand. If this is true, then combat service support organization and doctrine must function in a fluid, day-night combat environment of unprecedented intensity. There is no historical usage data for this war whether it stays conventional or goes nuclear. Another important consideration is that the enemy is well equipped and trained for chemical warfare and we are not. This may be a more likely

mode of combat than nuclear war, which can have such an irreversible finality.

The long established methods for such human support functions as bathing, hot meals, rest, treatment of the wounded, and for grave registration and processing of the dead in the continuous combat environment will pose new problems of unprecedented magnitude. Whether the war remains conventional or goes nuclear, the numbers of men wounded and killed will be very large. If the pace of combat does not let up and there is no clear demarcation of lines of battle contact, then even the removal of the wounded by helicopter, so useful in Korea and Viet Nam, will not be possible. There must be anticipation of this problem. In World War II the Soviets trained dogs to find the wounded. A technology solution might consider a cooperative transponder with a version of a dead man's switch actuation. The new minaturized life monitoring systems developed by NASA, together with microprocessor technology, could provide a very sophisticated but cheap, reliable vital signs sensor and transmitter. The output, on command or on program sensing of aberrations in vital functions, could inform medical support personnel the condition and location of a casualty. The unit could also locate the dead on the basis of the transponder so that the combat service function associated with this aspect of combat could be done quickly when there was the opportunity to do it.

Soviet medical teams that are especially equipped for radiological, chemical, and biological warfare casualties are deployed forward in APC type mobile medical vehicles. They move with the combat echelons one to 1.5 km behind the combat unit. This concept can be used by U.S. and NATO combat forces. This method of medical support is opposite to efficient peacetime operations particularly with the shortage of doctors and medical personnel. However, if all aspects of combat service support are not developed and applied as "normal" in the routine support of combat equipment and vehicles, and of combat units, they will not be evolved under the pressure of continuous combat.

9.4. Maintenance Implications in Sustained Combat

Modern land combat is becoming increasingly dependent on machines. The combatant who can keep his machines fueled, armed, and functioning will have had a significant advantage over one who cannot or one who expects to use pool and rear base concepts of maintenance and overhaul.

The Israelis provided the modern example of the essential requirement for forward maintenance in the Yom Kippur War. Their mobile maintenance vehicles and repair teams, operating in the immediate combat area, turned around more combat vehicles and tanks than they owned at the start of the war. Had these damaged and broken-down vehicles been tagged for repair at rear base overhaul and maintenance facilities they may not have a second, and in many cases, third opportunity to be used in a very active 20-day war and the outcome of the war would have been very different. Forward-based maintenance teams must do more than triage the damaged equipment. However, this is a very important first function -- to determine which pieces of equipment can be repaired forward in the battle zone, and in what order, with the criteria being to repair first

those vehicles most essential to the combat objectives and most likely to be repaired in time to affect the combat outcome.

In the Great Patriotic War, the Soviets document that 85 percent of battle damaged combat vehicles that could be fixed were repaired forward by mobile maintenance teams. As with the forward operating medical teams and consonent with the Soviet "equal mobility" thesis, maintenance teams working from specially equipped maintenance vehicles are attached to the combat echelons and move with the combat forces. They are assigned according to need and the level of combat activity and not distributed per combat division. Economy in specially trained high technology personnel, as well as specially configured maintenance vehicles and equipment is achieved by aggregating combat service support at higher echelons of command, tailoring their assignment in task force fashion to combat units which are primarily combat configured. Logistic support units are organized in the same way. This is opposite in concept to the distribution of support personnel among combat divisions so that each division has the staying power for possible expeditionary force responsibilities.

9.5 Maintainability Concepts

Continuous modern combat is made possible by the complete mechanization of combat and combat support forces. Modern armies are increasingly machine dependent. To fight at night and at increasing stand-off ranges, sophisticated and advanced technology target acquisition, fire control, communication equipment and black boxes have become essential parts of the combat and support vehicle system package. Advanced technology equipment and unreliability have become synonymous, a bad rap, but a reputation well deserved based on the experience of combat forces who have found themselves equipped with complex machines that can't be kept working./86/ In the continuous combat environment reliability and maintainability may become a more important criterion of combat vehicle effectiveness than more obvious parameters like muzzle velocity, rate of fire, or rounds per minute.

Equipment considerations that affect battlefield maintainability include:

* Design
* Modular construction
* Self-contained fault isolation
* Throwaway components

/86/ The Sheridan M-551 has been cited as an example of advanced technology weaponry that has made combat commanders skeptical of technology "solutions." "Every time the [M-551] turret is fired it takes three PHD's three weeks to get it working again." Technical discussions, Armor Center.

* Improved operator/organizational maintenance capability.

There have been efforts to achieve better maintainability and reliability mostly by tough contract specifications. The sub-systems that are often the first to go when costs start getting out of hand are the added cost items that were intended to enhance maintainability but which the combat vehicle weapon system could perform without, but not for long. Special tools and spares are also sacrificed to gain budget dollars today at the expense of tomorrow.

Ideally, each combat vehicle, as a total weapon system, could be made completely self-checking, maintainable by the operating crew, and with no special tools. This could and should be done. It is an area where an advanced research program could have a major impact on the combat effectiveness of the land combat forces. If it were necessary to develop all the essential technology from scratch, the costs would be prohibitive. However, the sensors and microprocessors that are available would have been considered too esoteric and complex for practical consideration except that these are now practically "on the shelf." The paradox is that the very sophisticated microprocessors, integrated circuits, and related solid state electronic devices can perform with ease the monitoring, sensing, and data handling, functions at a high order of sophistication. Once development and design costs are amortized, the "chips" are amenable to mass production techniques, are of small size, reliable, require low power, and unit cost is so low they can be "throwaway" components.

These microprocessor techniques could be pushed to extraordinary innovative lengths with little added vehicle costs. It is conceivable that fault isolation could be extended beyond failure or incipient failure indication. By means of a small central computer, the data might be linked into larger capacity computers and up the supply chain by packet communications technology. Without manual processing these functionally programmable data processors could identify the part, the vehicle, the vehicle location, establish the availability and location of a replacement, and accomplish the fowarding of that part as a function of the urgency which, in turn, could be programmed as a function of the combat dependence of the vehicle. All of the above is well within the current or reasonably available "state-of-the-art."

Built-in Test Equipment has already been applied to advanced technology components like inertial-doppler navigation, aircraft radars, missile circuitry, with some limited success. The application of BITE to these sophisticated, expensive weapon systems leaves the impression that this concept is limited to high cost systems of this kind. However, the concept is sound, the fundamental technology can be gotten in hand, and in fact, extended as described above, and once development and research costs are written off, can be produced cheaply. These solid state components should be very reliable in the crude, rough combat vehicle environment -- vibration, shock, dirt, wet.

A total systems approach would have the best pay-off in design concepts for the continuous land battle. Maintenance and logistic support considerations include the following:

* Repair, resupply, and service support forward in the immediate combat zone, probably at night, in a nuclear environment or under threat of it; in a chemical war environment or the threat of it; in a biological war environment or the threat of it. Night viewing goggles, protective overgarments and masks, rapid erectable maintenance shelters.

* Immediate repair and resupply in whatever conditions prevail. Deferring repair and combat service support functions to a better time in a better location may not be possible because of the pace and the intensity of combat.

* Modular replacement made possible by design. It might be expedient to replace major modules even though a minor but time consuming component repair would be more economical if time and the combat environment were not overriding considerations. Major modules would also simplify the supply and inventory problem.

* Throwaway design. War is wasteful. Processing equipment back into production line repair may be good economy in operating a truck fleet however, combat vehicles, including trucks, might also accommodate to component repair but only as a secondary condition and only where it did not subtract from modular replacement and the throwaway actuality of the combat environment.

* Common modules to the extent that it is possible in the entire family of vehicles. This would ease the problem of cannibalization from beyond repair or beyond immediate repair vehicle carcasses in the battle area. These commonality considerations should apply not only to U.S. vehicles but throughout NATO. In concept development of modern combat and support vehicles it might be worth considering component convertibility with enemy equipment, that is, Soviet equipment. The Isreales have converted large numbers of captured Soviet equipment to operational use in their own combat forces.

* Triage decisions in the combat zone depend on the ready availability of a component or part. There is no time for manually filling out parts procurement requisition forms and usage or failure reports. It is well within the capability of microprocessor technology and computer-based management information and computer netting methodology to maintain a total inventory control in the most fluid and confused situations. As was discussed earlier, fault detection BITE systems can be extended well beyond "go, no-go" indications. For example, part number, component replacement required, vehicle type number, vehicle location, organizational assignment data, and other pertinent hardware and operational information could be entered automatically into or functionally occur within a small vehicle control data computer. Vehicle condition, parts components, logistics requirement, could be output from the vehicle computer automatically in a cassette, magnetic card, or strip format. This, in turn, when inserted into the mobile maintenance van computer of

a management information system configuration could, by using advanced programming inventory control techniques, locate the part, effect delivery action, or provide options to the crew of the forward mobile repair unit. It could net, without interference, into command, control and communications nets by means of information handling packetting techniques.

It is in all aspects of digital computer design and applications, in microprocesors, in electronics, and in solid state physics that we have the longest technology lead over the Russians. The major impact that these technologies can have are in some of the actualities of continuous combat briefly touched on in this section. This flys in the face of mental conditioning and unconscious prejudice that sophisticated advanced technology like the above have, or should have, primary application in such sophisticated areas as high energy lasers, in space and strategic warfare, in antisubmarine and underwater sound problems, and that maintenance and design of half-ton combat vehicles, trucks, and even tanks are mundane problems whose technology is well established and well known, therefore not an advanced research problem. Yet, it is in the continuity of maintenance and combat support that the continuous combat war can be lost whether or not satellites are destroyed or protected. Somehow these priorities that are mandated by the actualities of war have to be got into order of combat impact, not glamor.

All of the advanced maintenance techniques that apply to spacecraft, aircraft, and missiles can economicaly and practically be extended to combat vehicles without prejudicing the reliability of the vehicle but rather enhancing it. The systems would not be simple, the stated weapon system ideal, which is at the same time both correct and misleading. They would be beyond the understanding of the ordinary soldier or technician, but they would never be intended for that understanding or repair by these operational personnel whose responsibility it is to use the weapon systems and combat vehicles without concern as to whether they are complex technically or not.

10. Training and Human Factors

10.1. The Human Factors Problem

The actualities of modern continuous combat will push human capabilities to their absolute limits and beyond. Some that come readily to mind are:

* Fatigue, whose debilitating effects will be magnified under the stress of intense combat without let-up.

* The requirement to operate at night when man is functioning under highly unnatural conditions and has psychological reactions that are completely different.

* Dependence on the combat vehicle for armor, mobility, and NBC protection requires a sealed, tight space that will induce claustrophobic anxiety.

* The fear and inducement to panic under the threat of invisible chemical, biological, or radiological attacks, real or rumored.

* Noise and stress of modern weapons, and the inconceivably awesome power and effects of nuclear weapons.

* The casualties that mass destruction weapons can cause both in numbers and in horror may be beyond human capacity to accept and to continue effectively./87/

All of these actualities of war will prove to be decisive and the advantage will quickly go to the combatant who has best projected the combat environment, developed doctrine suited to the next war and trained and psychologically prepared his troops, the officers, the commanders, and, perhaps most important and most difficult to achieve, the political leaders for what may come. More ominous and most vital, what will come if we are not prepared, if combat capability continues to erode because of economic priorities, if there continues the most optimistic estimates of Soviet intentions and of the absurd conviction that the Russian is technologically and intellectually inferior.

Assessing intentions is an intellectual exercise, an imperfect art. Even if perfectly done, intentions can change overnight. The capability to match those intentions through doctrine, organization, training, and most of all with equipment, takes a great deal longer to realize. These

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/87/ This alone is a powerful argument for the echelonment of forces concepts of the Soviets. A battalion or combat unit that has undergone chemical or nuclear attack may no longer be capable of going-on. "Can-do" spirit can only go so far and when it breaks it breaks sharply. Replacing casualties from pool resources with the expectation that the unit, now brought up to organizational strength, can continue may not be valid in modern war. An entirely new unit which has not yet experienced the horror is more likely to be effective. This is possible within the framework of the Soviet echelonment doctrine.

are the only considerations that can and should be relied upon because they are manifest in tangible hardware. It can be counted. It will not go away. It can be measured. Estimates of intentions can be, and usually are, philosophical and politicized.

In the context of the actualities of modern continuous combat SU A.A. Grechko (Former Marshal of the Soviet Armed Forces) notes that a war "will not only be an opposition of equipment and weapons. War is waged by people, and man remains the deciding force. Therefore, along with weapons and combat equipment ... preparedness ... will take its place on the scales of victory ... Now, as never before there has been an increase in the role of moral-psychological training of soldiers ... Steadfastness, independence, resolve, and an inexorable will to win -- these are the qualities which must be instilled in Soviet soldiers."/88/ U.S. Army Chief of Staff General Fred C. Weyand stated the continuous combat problem this way: "We must be prepared to fight round the clock, 24 hours a day in any weather ... Readiness is developed and then reinforced by tough, demanding, realistic training ... Superior equipment cannot make up for lack of knowledge and the will to win."/89/ Almost the same words as Grechko. The very respected combat commander, General Erwin Rommel, the German "desert fox", summed it up in the statement, "The best form of welfare for the troops is first class training."

10.2. Training

There is consensus that hard, tough training is not only essential but is the most important factor in achieving combat effectiveness. But training to do what? This must first be clearly defined in doctrine and then enabled by organization and equipment. The promulgation of doctrine for continuous combat operations, a key recommendation of the TRADOC directed study of the Army's goals in night combat, has not been implemented except as encouragement about the importance of night combat and the pursuit phase of combat operations.

The conception of innovative modern doctrine for continuous combat is an essential first step without which there can be no concert in the effort to achieve a continuous combat capability. The promise first to work on night operations then go on to the more difficult problems and implications of continuous combat obscures the actualities of modern combat and postpones getting to them (Discussed in Section 6.0).

About night training, accepting that night combat operations are essential but not sufficient for continuous combat, doctrine is fragmented and not consistent. Night operations are made special, to be avoided and feared, not by doctrinal statements and resolutions which are consistently "can-do" and inspirational, but by regulations and "safety is paramount" requirements issued by the same authorities that establish a "one-third after darkness" goal and who then emphasize the importance of hard tough training. By appending "safety is paramount"

/88/ "The Basic Principles of Operational Art and Tactics," V. Ye. Savkin, Moscow, 1972, pp. 95, 96.
/89/ "Army Research and Development News Magazine," November-December 1975, p. 40.

warnings to hard, tough training exhortations, the onus is passed down to the battalion and company commanders as a "number one priority." They already have too many number one priorities but now must meet night training goals as well, and will, and do. But every opportunity will be taken to meet the goal when the real goal should be quality of hard, tough training.

Demands for safety such as keeping all vehicle headlights on, having a guide with a light walk in front of combat vehicles, and the prohibition of the movement of company sized or larger units at night, while undoubtedly safe, are so artificial as to make the time spent training this way useless and resented.

For these reasons, the amount, type, and quality of night combat training was criticized by enlisted and officer personnel and the commanders as well. It was agreed fifty percent of all training should be at night and that it must be meaningful, tough, high quality training. This kind of demanding training, so long as it is well conceived and well done, increases morale far more than so called quality of life amenities. Consider any tough, highly trained combat unit. They worked long and hard to achieve a capability beyond that of the "average" soldier and it shows in their bearing, appearance, and morale. As numbers of personnel go inexorably down and the demands of modern warfare go up, it is conceivable that selection and training, usually reserved for elite units, will be essential for all personnel. This applies to service support units with the same emphasis as to combat units.

The continuity of resupply, medical support, repair, and the provision of essential human requirements are as critical as are night trained and equipped combat forces. The intense, continuous pace will not allow any slack. DISCOM does not usually train at night except in support of an FTX. However, all supply and maintenance personnel should train in the same environment and at the same pace as the combat units they support. Medical personnel are in short supply and are fully occupied with peacetime responsibilities. But these also must be organized into mobile, specially trained teams operating from armored medical support vehicles specially configured.

The importance of community and civil relations override training priorities. A realistic electronic warfare environment would interfere with television and civil communications. A ground-to-air and air-to-air combat environment might be considered a hazard to civil aviation and cause community disturbance from the noise and sonic booms. Low altitude flight in Europe is limited to not below 2,000 feet; not very low and not much training for terrain contour flying. Real estate for large scale training is limited in the United States and even more limited in Europe. No German farmer wants large tank formations charging over his land no matter how serious the Soviet threat. Large scale exercises in the United States usually are held in desert and "wasteland" areas that are hardly representative of Europe where the most critical of wars will be fought. Training areas are surrounded by well-lighted communities. This will not be typical of actual modern night combat. Continuous combat training requirements are much more extensive than night training. Biological rhythm and diurnal changes in efficiency and effectiveness of

the human animal must be considered and induced in training. This can only be experienced by going on for extended periods. Reverse cycle training would be useful but garrision, family, and community responsibilities work against it.

10.3. Common Doctrine

All of the above represent a list of some of the major problems. What of solutions? First, it has been recognized in FM100-5 that a war in Europe would have to be fought by the combat forces there with the resources they have at the start of the war. This means that, above all, they must be organized, configured, equipped and trained to meet the Soviet continuous offensive, day and night, in any weather, and to meet conventional, nuclear, chemical and biological attack. Training derives from doctrine (as does everything else). So the doctrine for continuous combat is the most essential element. It must be a common doctrine applicable and acceptable throughout NATO. It will be a coalition war and interoperability of equipment, procedures, doctrine, communications, command and control, is fundamental. Yet, until recently, coalition warfare has had little attention. Every major modern war, even Viet Nam, in which the United Stated forces were involved, was fought alongside Allied forces. Therefore, common NATO doctrine for continuous combat needs to be developed upon which to base organization, training, and equipment.

Common NATO doctrine will have to be based on the most comprehensive, objective, and widely distributed knowledge of the enemy, the Soviet and Warsaw Pact forces. "The cardinal sin in military leadership is to fail to recognize the nature of your probable opponent."/90/ The Air Force translations of the Frunze Academy documents are an excellent step in that direction. They should be required reading not only within the combat forces but throughout DoD and the technical and support organizations as well. "Soviet Military Strategy," by V. P. Sokolovskiiy, Marshal of the Soviet Union, is another essential document.

10.4. The Actuality of the Threat

The Soviet Military thought series becomes a threat actuality when the weapons and equipment that are essential to the implementation of that thought are first observed. When that equipment is put into the hands of the operational forces, the matter is beyond technology catch-up. We are then, and in most instances, too late.

Some examples:

Siderenko — "The offensive ... will be conducted night and day ... without let up until the enemy is defeated." All Soviet military vehicles have been made night capable since 1963 albeit with active IR systems initially. However, the equipment on the Israeli cap-

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/90/ "Soviet Military Strategy," V. D. Sokolovskiy, Edited with Analysis by Harriet Fast Scott, Stragetic Studies Center, Stanford Research Institute, p. xv.

tured Soviet BMP-76 PB was an advanced passive thermal imaging device.

Chuikov — "No water obstacle in Europe or Asia will stop us." Soviet bridging equipment is acknowledged to be second to none and their forces are completely equipped.

Sokolovskiy — "An offensive should be mounted primarily in tanks, mechanized infantry combat vehicles, and helicopters. Dismounted attack will be a rare phenomenon." The BMP-76 BP is considered by many to be the most advanced infantry combat vehicle in the world today. It was made operational in 1967 and is the means to implement the projected mounted combat doctrine of Sokolovskiiy. There are many other examples.

When hardware is put into Soviet operational units to carry out what is projected in military doctrinal literature, there is in being a threat and a challenge that must be met or you are defeated, if not in battle, which may never come, then in negotiation. Intellectual estimates of intentions, the belief that the Soviets are mentally and technically inferior, that they do not train enough to do what they state in doctrine and have equipped themselves to do, that they are rigid, not flexible, and will fall apart if the basic operations plan is forced to change, that they are rail dependent and logistics limited, that only second-tier officers are assigned to logistics therefore they will be unable to keep up, all of these are opinions in justification of the reasoning that the threat is less than the hardware forcibly indicates. Any or all of these points, which emerged in technical discussions in the course of the study, may or may not be true. None of these is so tangible or has as much meaning as equipment and weapons that can do exactly what is said in the doctrine. There is a cold finality in the existance of a weapon or machine of war that cannot be rationalized away.

This is not intended to suggest that the Soviets are "ten feet tall", another typical response to the presentation of measurable continuous combat actualities. They are not. Many Soviets are, indeed, 5'-6" tall by specification to fit into their low-profile tanks. But there are more than 40,000 tanks, all of them night capable, that can snorkel or swim, equipped with self-contained navigation systems, with formation lights, that have the ability to smoke, and which are completely equipped for NBC warfare down to protective overgarments as part of vehicle issue, not in warehouses.

10.5. Potential Technical Solutions to Continuous Combat Training

After it is accepted that common doctrine must first be developed to meet the Soviet threat of the continuous offensive, that doctrine can then serve as the basis for the hard, tough training to which all ascribe. There remains the other problems concerned with night/continuous combat training which have been touched upon briefly earlier, problems that can only partly be solved by technical solutions.

It has been submitted that the entire burden and responsibility is being placed on the combat unit commander when it is demanded that realistic training in darkness be conducted for at least one-third of the training period, and at the same time there is imposed totally artificial safety restrictions such as "headlights on", "man with light to precede vehicles", and "no movement of company sized or larger units at night."

Some compromise on these safety standards can be made after there is broader application of night vision devices and night driving equipment. These may provide more confidence in night movement and allow a lifting of some of the safety restrictions. (Some of the problems with current night vision equipment is presented in Section 6.0.) However, even if there were night glasses available with the capability to turn night very nearly into day, the fear and strangeness of night would remain. This innate fear can be turned into advantage only by training. Soldiers in highly developed countries have farther to come than those in more primitive, developing nations. However, once well trained, as were the Ranger units in WWII, the modern soldier is a formidable night opponent. It should also be noted that the major problems of continuous combat are only partly concerned with night operations. Major doctrinal and organizational issues are far more important and more difficult.

If modern combat is to be continuous as has been projected by the Soviets, then so too must training. Night training that continues through the day and on into the next night and the next must be conducted by small units as well as in large scale field exercises. Fatigue, rest, and restoration problems will come up that will not emerge on a sporadic night training schedule with rest expected and planned the following day. Reversed cycle training for a reasonable period, at least two weeks, is worth considering. The diurnal, very marked decrease in effectiveness that occurs as part of the biologicl rhythm of the human animal, will be encountered only in extended reverse cycle training. This serious reduction in efficiency, judgment, and coordination, which is unnoticed by the individual, can be dangerous, not only to the soldier and his equipment but, where it is a commander or his key staff, the entire operation can be put in jeopardy.

How can this be recognized or corrected?/91/ There are measurable physiological changes that correspond with the drop in efficiency. By combining NASA space program body function sensors and transducers with microprocessor technology, together with advances in large scale integration, a small, inexpensive and reliable sensing and warning device could be developed particularly for highly skilled personnel.

It might also prove useful to issue these to all personnel on the modern battlefield. The device could also serve as a cooperative tran-

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/91/ It was observed in technical discussions at the Army Aviation Center that the low efficiency period corresponded to a drop in body temperature that could be determined using a rectal thermometer. However, this was discarded as a practical measure particularly as it might be applied to the commander in the field. The flight surgeon demurred responsibility for its implementation.

sponder that would signal that a soldier was injured, or wounded, or worse. His condition and location would be transmitted to medical teams. Recovery of the wounded will be a serious problem in dynamic, fluid intense modern combat without front line demarcation or pause in combat activity.

As an effectivness indicator it might warn the onset of physiological indications of decreased efficiency, then sound a positive alarm, which like a repeating alarm clock, could only be turned off for short intervals.

There has been a great deal of notoriety given to mind altering drugs and stimulants. There is a stigma attached to the entire subject and it is precisely the kind of thing that the media irresponsively distort when military applications are considered. However, drugs, high energy foods and mood elevators, may be critical in the modern battlefield. There may be a very significant pay-off in this direction of research. It should be pursued seriously. However, it would be prudent not to undertake it subrosa. Too much mischief could be made of this important research area that will be most essential, perhaps critical, to a sustained combat capability.

Another serious problem with stimulants or suppressants is reversing their effect when it is necessary to do so. For example, a combat unit whose survival depended on going on despite severe fatigue, after using a stimulation drug, might suddenly find itself out of active combat and into a waiting status with a chance to rest. They could not take advantage of perhaps a rare opportunity until the effects of the stimulant wore off. Conversely, a combat unit keyed up by combat, might be unable to calm down enough to rest. Should drugs be used to induce relaxation, how could their effect be reversed quickly if the fluid combat situation forced the demand to fight or to move quickly?

There has been some interesting research on control by the individual of the brain's alpha wave activity. Research by SRI on the disturbance of sleep by sonic booms used the brain's alpha wave activity to establish the level of sleep of the individual. There have also been reports of Soviet interest in alpha wave phenomenon. Is it possible to influence the alpha wave activity of the brain by training or conditioning, or more positively, electronically without getting into an a mind control controversy? If this could be done, particularly by positive electronic means, efficiency and alertness could be increased for combat or repressed when there was an opportunity to rest.

There are training area artificialities caused by the lights of nearby communities. A technical approach to this (and other problems discussed later) is possible because of the almost complete dependence on mechanization and night observation and target acquisition devices for night operations and continuous combat. What is being suggested is the opposite of illuminating the battlefield. Instead of turning night into day, include circuitry and technical provisions in target acquisition, surveillance, night vision and night observation devices that can turn day into night.

It should be possible at reasonable cost in this era of the microprocessor and integrated circuit technology to simulate completely realistic night and adverse weather visibility conditions electronically rather than attempting a brute force solution like dark optical filters.

If devices, or incorporated circuitry of this kind, can be developed then realistic night lighting and visibility conditions can be introduced for the combat personnel in training yet safety observers and monitors can have the benefit of broad daylight to detect and correct potentially dangerous situations before they occur. A unit getting into trouble could quickly go to daylight when warned.

As an extension of the above concept, targets, battlefield hazards, battlefield noise, smoke and confusion which can be artifically created in static simulators could be transmitted by data link to tanks and combat vehicles moving on test and operating ranges. The noise, vibration, problems of motion and acceleration, as well as dynamic forces and effects that cannot be introduced in static simulators, could be experienced by combat crews when battlefield effects and problems can be transmitted by means of data link to the vehicles that are moving at combat speeds and in combined arms combat formations on the training range. The techniques used for generating and imaging battle effects could be similar to those developed for training devices and combat simulators. Nuclear, chemical, biological warfare conditions could be projected and introduced with as much realism as possible.

Reaction times and accuracy in taking image generated targets under fire can be measured. The effects of live fire could be simulated by two-way data link even to the weapon tracking of the trajectory. The crew, of course, would have the benefit of live fire training, actually shooting at an enemy target that wasn't there. The realism of this kind of simulation within an operating combat vehicle is almost without limit and at affordable cost if the provisions are incorporated in the equipment in the initial design. Multiple target problems as well as ammunication resupply problems could be introduced.

We have not pushed or even approached what is possible in the military applications of microprocessor technology. This area, where we are considered to be way ahead of the Soviets, has come largely from the civil economy. Civil applications range from TV video games to very advanced hand calculators and further applications are growing explosively.

New and innovative solutions to mundane, but difficult problems as well as sophisticated, and more difficult, military problems are possible with advanced microprocessor and computer technology which has been growing exponentially in capability. Equally important, there have been dramatic decreases in costs and reliability increases as well, the best of all worlds.

Continuous land combat, in all of its aspects, is our most vital problem. The maximum exploitation of our advanced microcomputer technology should be made. This can be done by a synergistic combination of systems and operations research studies to identify and define the

operational problems of continuous combat with the technology that is available, emerging, or potential with reasonable risk.

Large scale field exercises are essential to working out coordination problems, evolving and testing joint doctrine, and to the achievement of a total combat capability. Combined arms large field exercises are a graduate course for those units that successfully completed the undergraduate unit training. Very large representative geographical areas, difficult or impossible to come by, are necessary. The cost and coordination problems to bring together many combat units including those from other services and NATO countries, are equally formidable.

It may be possible by using the same kind of technical approach described above wherein simulation circuitry is integrated into combat vehicle and weapon system target acquisition, communications, surveillance, fire control, and navigation equipment to dynamically simulate the large field exercises coordination problems yet keep the size of the combat and support organizations physically maneuvering in the field to an optimum yet manageable size.

What is suggested is that a large combat unit or units could be put into a reasonably sized training area so the dynamics of vehicle movement, terrain, live fire, and other battlefield realities can be experienced physically. However, the large scale problems and realistic battle effects will be simulated. Jamming, communications, enemy units, and other battle effects will be generated and transmitted to the units in the field by data link.

The overall large organizational and NATO coordination problems could be introduced by combining the field maneuvering unit into large scale war gaming, combat computer simulation, as well as CPX and headquarters simulation training in the dynamic control of the exercise. Only the maneuver unit would be in the field but all the other combat units operating in simulators and on the game board could be linked together just as though they were also in the field but out of line of sight.

Should combat vehicles be equipped with such advanced technology built-in dynamic simulators, it may be possible for combat units maneuvering in "free-play" field exercises in CONUS to link in real time via satellite with similarly equipped NATO CPX and mechanized units in the field in Europe. By means of these systems, combined arms exercises using coalition warfare doctrine could be conducted between units that would be out of LOS anyway but instead of being over the next hill, they would be on another continent.

Jamming and electronic warfare problems could be introduced by imagery simulation and computer modeling of those effects. The EW results by and against the combat maneuver units would be analyzed by computer and transmitted back immediately as an imagery feedback. Vehicle EW emissions and communications could be trapped by devices coupled to antennas and relayed by closed loop to master computers. In this way, a jamming environment and the battle penalties of indiscriminate transmissions could be introduced without disclosing EW capabilities to hostile

monitoring and without interference with civil communications.

An additional benefit to what is an admittedly ambitious but perhaps essential technical approach to large scale combat training for sustained combat is the command training that could be had at all levels as well. This may indeed be the most important payoff. Training combat commanders for modern continuous combat which may go chemical, nuclear or biological is a demanding and a vital necessity. There has been no precedent or historical example of sustained modern combat from which to learn nor will there be the time to learn when war starts. The pace and the pressure will be too furious.

The approach discussed above is a continuous thread of perhaps increasing complexity and technical sophistication. It may represent a solution to the many very difficult problems of training advanced mechanized combat forces for continuous combat. It is predicated on exploiting microprocessor technology by incorporating the circuitry and technical provisions in operational equipment in the initial design. The training benefits can be pyramided from simply the introduction of restricted visibility problems to large scale field exercises that are not large scale and are conducted in the field by maneagable sized maneuver units whose size can be determined by feasibility studies.

11. Nuclear, Biological, Chemical (NBC) Warfare Considerations

11.1. Introduction

The pattern is the same with regard to NBC mass destruction weapons as it is with the weapons and conventional means of warfare. Specifically, the Soviets are developing, at an alarming rate, a war fighting and a war winning capability whether the war be conventional or NBC. The countries of the NATO Alliance have adopted a war avoidance posture whose principal bulwark has been the superior nuclear strength of the United States. The once wide margin of nuclear superiority of the United has narrowed to a thin edge even under the most optimistic of projections and there are strong arguments that can be made that the advantage in nuclear weapons has gone to the Soviets.

Chemical weapons were renounced as offensive instruments of National Policy by President Nixon in 1969. Robert S. McNamara, then Secretary of Defense, shed that repugnant capability with enthusiasm. The Soviets accepted the advantage given to them and accelerated their chemical warfare manufacture and training activity.

Biological weapons are considered to be disgusting and terrifying instruments of war. Their development or hint of development by the United States as a deterrent or counterbalance to Soviet biological weapons is exaggerated, distorted and widely published in the news media. The Soviet political leaders simply use these articles, fictional or no, to illustrate to the Soviet people the reasons for their biological weapon program -- weapons, training, protective overgarments, sterilization equipment for tanks, combat vehicles, and men, medical vans, specially trained medical personnel.

NBC weapons, as their employment is projected in Soviet military writings are simply weapons for modern war. Since they exist they can be used and so doctrine, training, organization, and equipment must be and has been developed. Troops must be psychologically conditioned for the horror of the battlefield environment that will exist should these weapons be used. They have. Equipment must be in the hands of the operational forces to fight and win using or resisting these weapons. It is.

NBC weapons do not negate the concept of continuous combat. They rather emphasize why this will be the character of modern combat.

11.2. Nuclear Considerations

Nuclear considerations as they affect the capability of U.S. and NATO combat forces to meet the Soviet continuous offensive pivots on a posture of war avoidance. We have nuclear weapons and profess the resolve to use them. Thus, the Soviets are deterred and war avoided.

The NATO nuclear capability is vested in more than 7,000 United States warheads locked securely in nuclear magazines and heavily guarded by U.S. Military Police. The location of these magazines is an open secret. The nuclear weapons are controlled by the President of the United States and the release of the nuclear key enabling their detonation

is held by that office. There are also the instruments of nuclear weapon delivery to which the nuclear warheads, except those already at ready alert, would be transported after presidential release -- tactical aircraft, surface to surface missiles, SAM's and nuclear cannons, atomic demolition munitions (ADMs). Except for some radiation monitoring equipment issued to operational units, this is the essentially the sum of the capability for tactical nuclear war in Europe. It was perhaps enough when the Soviets did not have an atomic bomb. But they have had it for almost 30 years, and they jumped ahead with hydrogen bomb development.

U.S. developments in nuclear weapon technology has been toward ever smaller yield weapons presumably to reduce collateral damage and to explode them closer to our own troops. However, eye damage of friendly forces is likely even with "small" weapons particularly at night. Variable density goggles for eye protection of troops in the field have not been purchased because of their high cost although the equipment has been developed by the Air Force. It might be noted that the Soviets discuss the procedure of laying smoke and then turning combat vehicles back-end-toward the nuclear explosion.

The Soviets have not bought the defense intellectual's advocacy of small nuclear weapons. Their tactical nuclear weapons are large, dirty, and intended to hurt and hurt badly. Small yield weapons are purported to be essential to the flexible response and limited nuclear war policy of the United States.

Soviet military writers have long rejected the concept of limited nuclear war. In the late sixties, following the debates on U.S. counterforce strategy and tactical nuclear war, Marshal V. D. Sokolovskiy wrote in his "Military Strategy" (3rd Edition, 1968) on the dangers of escalation inherent in limited nuclear war:

> "Various limitations are mostly forced and conditional. A limited war is fought with a tremendous danger of escalating into general war, especially if tactical nuclear weapons are used. This is also recognized by American theoreticians."/92/

About the trend to small yield precision delivery weapons, two Soviet specialists on U.S. military doctrine wrote in the journal of the Institute on the United States and Canada (IUSAC):

> "Many Pentagon strategists essentially do not wish to change their military-political principles and are continuing to seek ways and opportunities to use nuclear weapons ... However, the possibility of unleashing a "small" and "painless" nuclear missile skirmish and keeping it within safe limits is a myth which in no way corresponds to the realities of nuclear war."/93/

/92/ H. P. Scott translation of Sokoloskiy's "Military Strategy," previously cited, p. 69.

/93/ A. Mil'shteyn and L. S. Semeyko, "The Problem of the Inadmissibility of Nuclear Conflict (On New Approaches in the USA)," SShA: Ekonomika, Politika, Ideologiya (USA: Economics, Politics, Ideology), No. 11, pp. 9-10 (November 1974).

A further consideration about small nuclear weapons as they affect the continuous offensive by tank saturated mechanized forces is that as the yield becomes smaller the accuracy of delivery must be more precise to achieve the same effect so more weapons and warheads are necessary. While there has been considerable technical development in precision guided munitions (PGM's), first generation PGM's depend on clear air-mass, high visibility daylight conditions; not at all typical of Europe most of the year. Next generation PGM's will have some night and weather capability at a considerable increase in cost.

The tank is a tough target so it will not be destroyed in large numbers by small yield, discrete weapons. P. A. Rotmistrov, Chief Marshal of the Armored Troops stated:

> "With the appearance of nuclear weapons, the supposition began to be expressed abroad that tanks would soon leave the scene as the cavalry had done. However, ... tanks continue to play a very important role, and tanks are the most promising arm of the ground forces."/94/

Even with the prospect of nuclear weapons being employed extensively and in depth throughout a theater of operations, the utility of tanks and artillery has not been reduced, in Soviet opinion, and may in some cases have been enhanced. This is because armor offers protection from air blast, infrared and penetrating radiation and permits the rapid exploitation of contaminated areas. The Soviets seem to think that PGM's may be more useful in many situations than tactical nuclear weapons."/95/

Instead of going to small discrete, precision nuclear weapons which will have to be delivered by means of costly PGM technology and, because of small yield, kill only one or a few tanks anyway, why not simply avoid the nuclear issue entirely and vest that development money in precision, multiple kill, terminal homing, conventional sub-munitions. If you spend all the effort to get close, whatever close means in the context of small nuclear weapons, it should cost little more to go far enough in precision guidance to get a hit. A conventional weapon kill mechanism will then be good enough.

All of the above bears on the U.S. tactical concept of stopping the Soviet tank-heavy continuous offensive by the package release of many small, "clean" nuclear weapons. Nuclear release for these many weapons would be requested for a time band, a time consuming process even under optimistic projections. Once the Soviet mechanized forces were stopped by this one-sided use of nuclear weapons, international pressure would force the Soviets to the bargaining table as would the demonstrated resolve on the part of the United States to use nuclear weapons, a resolve that is assumed not matched by the Soviets./96/ It might be

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/94/ Chief Marshal of the Armored Troops, P. A. Rotmistrov, Vremya i Tanki (Time and Tanks), Voyenizdat, Moscow, 1972, p. 274.

/95/ "Soviet Perceptions of the United States," William Carpenter, others, SSC-TN-3884-2, Stanford Research Institute, November 1975, unclassified, p. 155.

worth asking where the international pressure would come from since the most powerful nations in the world -- those of the NATO Alliance and the Warsaw Pact bloc -- will be locked in mortal combat presumably because matters were beyond diplomatic negotiation.

War avoidance, as it has been discussed above, is predicated on having large numbers of tactical nuclear weapons and presenting a posture of gradual response from conventional to nuclear which the Soviet's term the Schlesinger doctrine. It is a gamble based on estimating intentions rather than measuring and matching, or better, topping the war fighting capability that is vested in military thought -- available in Soviet unclassified documents for all to read, in organization and training -- reported on by the Soviets in the open press (perhaps optimistically) yet of such a scale as to be observed, and most of all, in the finality of equipment which can be seen and counted. Much of it has been tested and analyzed courtesy of the Israeli Defense Force. The thesis has been presented in this report that equipment is capability; it cannot be rationalized away with projections of intentions as to whether the equipment will or can be used. If the Soviets were capable of thinking out what equipment was required in modern warfare and capable of developing it they are probably capable of using it as well as anyone else.

All Soviet equipment is designed actually to fight a nuclear, chemical, biological, conventional war at night and in adverse weather and not simply to present a posture. Their tanks are low profile to better withstand nuclear blast without being knocked over besides being more difficult to hit. These tanks have a plastic and lead inner liner for better radiation and spalling protection. They can be sealed off immediately and go on separate, filtered conditioned air as can their infantry combat vehicles. They have automatic NBC alarm systems. None of our operational tanks or combat vehicles have these capabilities for NBC war fighting.

More specific in the sense of readiness for NBC war are actualities like wash down of contaminated men and equipment. Their logistic trucks include tank trucks for individual and vehicle washdown and sterilization, the latter an actuality of bacteriological war. This washdown and sterilization equipment, in operational inventory, has been developed from modified jet engines, truck mounted. These engines hose down the vehicles with large volume, high pressure, hot fluid which is pumped from tank trucks. Vehicles can be washed down at a rate of one tank every 1.5 minutes; combat vehicles, one per minute. (See for example, "Soldat and Technik, 5/1973, Einstrahlung, Engiftung, und Entseuchung Mit Sowjetischen Turbo-Triebverken" (Decontamination and Sterilization with Soviet Turbo-engines," p. 250). There is no counterpart U.S. or NATO equipment in operational use although to meet the actualities of NBC war this equipment is vital. In fact, you can't fight an NBC war without it.

/96/ Technical discussions, Command and General Staff School, Fort Leavenworth.

Another fundamental requirement for NBC war-fighting is individual protection -- overgarments and masks. Examination of 1973 Israeli-Arab War captured Soviet equipment revealed the following:

> "All of the new weapons are designed to fight in a battlefield contaminated by either nuclear or chemical warfare. Some of this capability is integrally designed into the tanks and armored personnel carriers in protective sealant liners and air intake filers to catch chemical, biological or nuclear elements from the outside atmosphere. The remainder of this capability comes from a wide array of protective individual equipment for crews that includes rubberized uniforms, breathing masks, goggles, gloves, dosimeters and anti-radiation sickness pills."/97/

This individual protective equipment is part of vehicle equipment and apparently in universal issue since this was equipment supplied to the Arab forces. Equivalent protective garments for NATO soldiers are usually kept in warehouses for future issue. Unless there is considerable warning time it may not be issued at all. Soviet tactical documents discuss who will wear masks and overgarments and when in a contaminated battlefield environment./98/

Training and psychological conditioning for nuclear war is emphasized by Warsaw Pact armies. As for doctrine, Sokolovskiy's "Soviet Military Doctrine" and Siderenko's, "The Offensive," as examples, are particularly detailed about tactics and doctrine for NBC war.

The concept of the infantry fighting while mounted is implemented in the BMP-76 BP which allows eight fully equipped troops to fight from inside the vehicle. A crew of three fights and controls the combat vehicle. An infantry combat vehicle of this kind is essential for protection in an NBC environment and to maintain the offensive momentum. Troops on foot can neither maintain the pace nor live in an NBC environment or on a lethal conventional battlefield while they are in the open.

It is the Soviet's belief that nuclear weapons far and away favor the attacker. The advantage of using nuclear weapons for breaking through defense forces that are tightly bunched forward/99/ is discussed as follows:

/97/ "New Soviet Weapons Unveiled in Mideast." by Robert Hotz, Aviation Week and Space Technology, Both sides of the Suez, p. 48.
/98/ "Tactics (The Officer's Library)," V. G. Reznichenko, October 1967; prepared by the Translation Division, Foreign Technology Division, Wright-Patterson AFB, AD-659 928, unclassified, p. 195.
/99/ "Strong standing forces in the East and the lack of maneuvering space in the West compel the Federal Republic of Germany and her Allies to maintain forces in place ... The forces in the Army must be deployed close to the boarder so that they can reach their defense areas forthwith." "White Paper 1975/1976; and the Development of the Federal Armed Forces," published by the Federal Minister of Defense, FRG, January 1976.

"Under conditions where nuclear weapons are employed, the breakthrough as a method for smashing the defending enemy and overcoming his defense will no longer have such decisive significance as formerly. The primary method of attack will be the launching of nuclear strikes and the swift advance of tanks and motorized rifle podrozdelenize into the depth of the enemy's defense through the breaches formed by nuclear weapons."/100/

11.3. Chemical and Toxic Warfare

11.3.1. The Problem

The Soviet/Warsaw Pact forces continue to maintain a superior capability to operate in toxic environments. They are the best equipped and prepared forces in the world to employ chemical weapons and to operate under Chemical, Biological, and Radiological (CBR) warfare conditions./101/

Neither the Soviet nor other Warsaw Pact policy makers and planners are being deterred, either for technical or political reasons, from including chemical weapons in their arsenal despite the singular unpopularity of "mass destruction" weapons that exists throughout the world.

Present United States policy towards chemical and biological warfare is based on adherence to the convention on the Prohibition of Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and their destruction, the BW Convention and the 1925 Geneva Protocol, both of which the United States has ratified.

Modern chemical agents and means of employment will offer significant tactical advantages to the user, even against a well-protected opponent. Should the United States be attacked on a significant scale with chemicals, while lacking the ability to retaliate with chemicals to redress the situation, it could force initiation of a nuclear response in order to prevent total defeat or a military disaster. As the Soviets achieve tactical nuclear parity, this option may become less viable.

Since President Nixon scrapped American development of chemical and biological weapons in 1969, the Russians have accelerated their own program -- which was initiated in the early 1950s. They have built up large stockpiles of nerve gas (especially thickened soman and sarin), hydrogen cyanide, cynanogen chloride and old-style mustard gas, as well as biological agents that would produce plague, cholera, anthrax and tularemia. The concentrations are stored in 40 depots in Russia and eastern Europe, and there are over 140 identified training camps where Soviet troops are instructed in surviving the conditions of a chemical battlefield. Soviet forces are equipped with protective suits (allowing 14 hours protection against chemical agents) and medical syrettes containing the V-agent antidote to binary nerve gas -- an antidote unknown

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/100/ "The Offensive (A Soviet View," A. A. Siderenko, Moscow, 1970, p. 62.
/101/ "United States Military Posture for FY 1978," by Chairman of the Joint Chiefs of Staff, General George S. Brown, USAF.

to the West until the fortunate capture of a Russian tank-driver by the Israelis in the Yom Kipper war in 1973. Russian military trucks, tanks and armored personnel carriers are equipped with filtration units, and decontamination squads are operating in all Soviet battalions./102/

11.3.2. Psychological Conditioning, Training

A massive psychological program in the Soviet Armed Forces is aimed at developing the physiological traits necessary to control fear and panic in any future war involving "weapons of mass destruction" -- nuclear, biological and chemical weapons./103/

The 1971 Soviet military publication, Soldat i voina (The Soldier and War), purports to be the first systematically researched study related to the psychological preparedness of the Soviet military.

The Soviets are endeavoring scientifically to mold the psyche of Soviet soldiers so that they will possess the necessary psychological qualities. They do this by drawing on Pavlov's study of "higher nervous activity" in man by the method of "conditioned reflexes." These conditioned reflexes, according to Pavlov, are "acquired by the body in the course of individual experience."

The reflexes can be conditioned during the course of repetitive training for chemical warfare. This is continually employed today in Soviet training exercises. Such a theory correlates with the thought that:

> "Habit is formed in man ... in the course of adaption to the environment (chemical warfare training for example). These (habits are automated actions timed for concrete specific situations."

Training is conducted during:

> "...periods of poor visibility and bad whether, over paths of movement complicated by obstacles and obstructions, under fast-paced situations and in conditions compelling the soldiers to carry out actions wearing their individual means of (chemical) protection."/104/

Only those soldiers with strong reliance on their weapons and equipment are considered to have the presence of mind and will to maintain combat effectiveness under conditions of chemical warfare.

Tempering is also achieved by teaching the Soviet soldier chemical reconnaissance, the use of protective measures for terrain and

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/102/ "Foreign Report," published by the Economist Newspaper Limited, London, July 1976, pp. 3,4.
/Military Posture for FY 1978," by Chairman of the
Joint Chiefs of Staff, General George S. Brown, USAF.
/104/ Colonel V. Fedorov and Lieutenant Colonel M. Nnidzhanian, "For Psychological Tempering," Voennyi Veatnik (The Military Herald), May 1972, p. 39

machinery, the construction of protective fortified positions and the action taken on receiving the signal of the presence of contamination while in realistic training conditions. All personnel are trained to carry out the specific actions of:

> "...overcoming contaminated zones, debris, fires, covering fuel and ammunition trucks ..., conducting decontamination treatment and rendering aid during attacks by toxic chemical agents."/105/

The Soviets are aware that the psychological reaction of their soldiers to toxic chemical agents is aggravated by the fact that they are not immediately perceptible to the sensory organs. There is even admission that members of the chemical reconnaissance platoons, lacking in a firm will, would become excessively nervous and exaggerate the danger of defeat. In an attempt to acquaint the soldiers with chemical weapons and heighten realistic training, the Soviets now employ toxic chemical training agents and radioactive dust in field exercises./106/

While the degree of success of inculcating such psychological qualities and morale as the Soviet Union hopes to instill in its soldiers is open to debate, the fact remains that the Soviet military forces have instituted a revolutionary system to identify the requisite qualities and habits they deem necessary to achieve victory in warfare in this age of weapons of mass destruction. To the degree they are successful, it will represent one more military advantage in their favor not only in general combat effectiveness, but dangerously so in the area of chemical warfare.

11.4. Smoke

11.4.1. Introduction

PGM's like TOW, Maverick, and weapons that rely on laser designation, are dependent on clear air mass weather and unobstructed visibility. These conditions are doubtful in the weather that is prevalent in Europe most of the year. PGM's are intended to be the primary defensive weapons for stopping the Soviet tank-heavy offensive. What might have been obvious, particularly in view of the Soviet emphasis on the battlefield use of smoke is that these PGM's are easily defeated by smoke. (All Soviet tanks and combat vehicles smoke. Operational U.S. tanks and combat vehicles do not).

Emphasis on smoke-screen concealment came after the 1973 Arab-Israeli conflict pointed out the need for protective screening in modern battlefield operations. During the 18-day battle, unscreened tanks, heavy artillery, and missile launchers were destroyed or put out of action at an awesome rate. A costly lesson, it spurred U.S. military strategists to set up a special task force to review the role of smoke and aerosols as screening agents in tactical operations. Improved smoke

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/105/ Major P. Leschinskii, "Psychological Tempering -- An Element of Field Training," Voennyi Veatnik (The Military Herald), March 1970, p. 97.

/106/ Ibid, p. 99.

systems are required to counter electrooptical-directed threats. Smoke systems that will screen tanks and other armored vehicles -- a grenade-launching system to produce rapid smoke curtains within 2 or 3 seconds, lasting at least 2 minutes in a 15 to 20 m.p.h. wind, and a vehicle exhaust smoke system using the vehicle's on-board diesel fuel are under priority development.

The British Armored Fighting Vehicle (AFV) Smoke System, used in their Chieftain tank, appears to provide the required U.S. capability for an instantaneous grenade-launched armored vehicle smoke system.

A "major thrust" is needed to advance technology for development of a large-area screening system. The requirement is for a nontoxic, noncorrosive, multispectral smoke agent which can be employed rapidly and that will blend with the operational environment.

Capability for large-area smoke screening currently is based on use of smoke pots and fog-oil generators, both of which are large fuel consumers. A compact, more efficient generator to disseminate all types of materials is needed. One of the concepts is tiny plastic beads soaked in fog oil that will release a large volume of smoke when heated/107/.

11.4.2. Soviet Concepts for the Use of Smoke

It is interesting to note that while the Soviets have an overwhelming advantage in tanks and combat vehicles, they also have larger numbers of antitank guided missiles -- SAGGER, SNAPPER, SWATTER -- in the hands of the operational forces to use against the heavily outnumbered NATO tank and mechanized forces. This is consistent with their war winning posture. They have also developed, refined, and are trained in tactics for the defeat of antitank guided missiles -- PTURS -- by combined arms tactics and the use of smoke, a lesson the Israelis and then the U.S. learned the hard way

The Soviet evaluation of tank countermeasures was stated by Colonel N. Nikitin as follows:

> "The abundance of antitank means unquestionably does not preclude successful operation of tanks on the battlefield. A well trained and coordinated crew can successfully combat antitank means. Cooperating closely with the infantry, artillery, helicopters, and aircraft, tanks are capable of successfully accomplishing the missions assigned to them in combined arms battle./108/
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> "... battle should be organized in order to suppress (destroy) the [PTURS] firing installations at the firing positions and the helicopters on the limits of "dependence" by the fire of infantry weapons, artillery and mortars; to destroy missiles

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/107/ "CB Defense" Frank Bender, National Defense, November-December 1975, p. 173.
/108/ Col. N. Nikitin, "The New in Tank Warfare," Znamenosets, No. 5, p. 38.

> in flight by the concentrated fire of automatic weapons; to blind (screen with smoke) and the boundaries for deploying the installations by firing smoke mortar shells."/109/
>
> "... the effectiveness of the fire of PTURS can be lowered with the help of smoke. However, for this purpose one should know the weak sides of guided rockets and skillfully exploit them. Thus, at the start of flight, for a sector up to 400 meters, the rocket is difficult to control. Therefore, in open terrain PTUR's can damage tanks only in a zone from 300-400 meter up to 2 to 3 kilometers ... Tanks cross a patch of 2 to 3 kilometers in 8 to 12 minutes. If, during this time, the PTURS positions are blinded or the tanks are covered by making a smoke screen, the problem will be solved. This can be done with the help of smoke rounds as well as using the existing smoke equipment of tanks (thermal smoke apparatus TDA or large smoke cartridges BDSH)."/110/

The requirement to operate tanks with supporting combined arms on the modern battlefield in order to improve survivability and effectiveness, suppressing PTURS with automatic weapons and artillery fragmenting projectiles, blinding the PTURS with smoke and putting a smokescreen over the tanks was discussed in technical and operational detail in Soviet military writing ten years and more before the "charge of the light brigade" futile and disastrous Israeli unsupported tank attacks against PTURS equipped Egyption infantry positions in the opening days of the 1973 Arab-Israeli War. It is incredible, therefore, that these fundamental and well-established tactical principles and basic weapons of modern war -- suppressive fire and smoke in combination -- should be regarded as a "lesson learned" from the Yom Kippur war and provide the impetus for renewed interest in smoke on the modern battlefield./111/

A Military Herald article in 1965 presents a number of Soviet uses of smoke and the results of field tests and exercises where smoke was effectively used./112/

/109/ Voyennyy Vestnik (Military Herald), No. 11, Military Publishing House of the ministry of Defense, U.S.S.R., p. 133.

/110/ "Blinding Antitank Guided Rockets (PTURS) with Smoke," by Maj. R. Finkel'shteyn, Military Herald, March 1963.

/111/ The same observation can be made about the jamming by the Egyptions of Israeli tank communications using Soviet battlefield jammers. The existence of this equipment has been known. Soviet capability and emphasis on jamming, deception, and electronic warfare is discussed in Soviet military writing with the same technical and operational detail as the use of smoke and nuclear weapons. Further, in a major U.S. field exercise more than five years ago, the agressor forces, using much more rudimentary jamming equipment raised havoc with the BLUE tank forces by jamming their tactical communications frequencies making elaborate frequency shifting necessary. It was reported completely and in detail as a crucial problem that had to be solved for tank and mechanized combat forces to operate effectively on the modern battlefield. Yet this too was a "lesson learned."

/112/ "Have Smokes Become Outdated," by LTC Engineer K. Klose.

* Protection against the flash effect of nuclear weapon detonations.

* Protection against Infrared and radar reconnaisance and target acquisition. The article states that IR devices operate in the spectral range 0.76 to 15 micrometers then proceeds to calculate the concealment weight and aerosol size for active and passive IR (thermal imaging) devices. "While concealment against infrared devices is complete, effective employment against radar ... depends greatly on the wavelength of the radar emission and the type of smoke used ... The low specific density of plastic smokes also permits their employment in conjunction with metal dust. This may greatly increase the reflection component."

The article concluded with the statement of the requirement for standardized smoke generators. The Soviets developed and have such a powerful variable density aerosol generator based on a modified turobjet engine mounted on a Kraz-214 all-terrain vehicle similar to the tank and combat vehicle decontamination and sterilization machinery described earlier. They tested the device extensively and reported the results -- persistence, density, coverege, particle size -- ostensibly for the dispersion of insecticides./113/

In the article "Employment of Smoke in Combat," Colonel P. Karmenko discusses field exercises where smoke was used to blind the launch positions of PTURS (antitank guided weapons), he also describes the use of smoke to blind conventional and nuclear artillery observation posts. An interesting presentation is also made of the tactical use of smoke in Soviet exercises to screen combat units from attacking aircraft "that make use of optical sights." The smoke was used not only to conceal but to present decoy units. "In the decoy area, along with setting up smoke release lines, reflectors made of angle iron were set up."/114/

On the basis of field exercises the Soviets conclude that smoke screens can reduce losses of attacking tanks and motorized infantry podrazdeleniyes by 60 to 80 percent, and blinding the enemy fire weapons reduces the casualties of our attacking forces by at least 90 percent."/115/

Other Soviet military articles document the use of smoke in city fighting, river crossings, camouflage and deception -- "False smoke screens ... laid down in those areas not occupied by one's own troops." the importance of using smoke by day and night is also discussed.

Source: Militartechnik No. 7, July 1965.
/113/ "The Possibilities of Using a Powerful Aerosol Generator for Studying the Propagation of Contaminants," by V. M. Sakharov, others. Source: Institut Eksperimental 'noy Meteorologii, No. 27, 1972, pp. 104-110, FTD-HT-23-500-73.
/114/ "Employment of Smoke in Combat," by Colonel P. Kamenko, Source: Military Herald, 1966.
/115/ "Under Cover of a Smoke Screen," by Major General I. Afanasov, Source: Military Herald, July 1972.

In an article on Soviet training aids, a discussion is presented of their use in providing a realistic training environment for repelling a tank attack made under cover of a chemical contamination screen, combat operations over terrain that is radioactive, and in the use of the turbojet decontamination and sterilization equipment (described earlier).

Eighteen chemical capsules were burst at a height of 20 meters above and to the front of the vehicles. The report stated: "It must be said that this "attack" did not take the personnel by surprise: the effects of previous training showed themselves. The platoon leader ... immediately gave the command "Gas; put on capes." All the men not under cover rapidly put on gas masks and protective capes. This was accomplished in 25 to 30 percent less than regular time.

Following the "chemical attack" the enemy began an offensive. The men of the platoon, wearing individual protective equipment, operated efficiently in repelling the enemy tank assault. Their fire was accurate and effective. After the combat mission had been accomplished, the commander decided to move out to an alternate position and carry out special decontamination."/116/

Two important points: First, this is hard, tough realistic training. To do what? To fight and win not posture and avoid modern mechanized warefare under chemical, nuclear, and biological attack. All of the above underscores this statement about the Soviet military capability made by the Chairman of the Joint Chiefs of Staff to Congress./117/

11.5. Some Potential Solutions and Recommendations

The most vital action that must be taken by the NATO Alliance nations and particularly by the United States since our combat forces are the key to the defense of Europe is to become credible in the capability for fighting and winning a modern continuous, intense war where NBC weapons of mass destructions are used or may be used.

We have many advanced technology weapons in development although our vaunted technology lead has many peaks and is rapidly being lost except in certain areas like computers, microprocessors, and large scale integrated electronics thanks primarily to the R & D of the civil sector. Our advanced weapons and systems are kept too long in development laboratories rather than getting the equipment to the combat forces and letting them evolve it.

The spikes and peaks of western advanced technology, while often exquisite in sophistication, are not always specific to the requirements for defeating the Soviets continuous offensive or even for presenting the credibility.

As discussed earlier, clear air mass dependent PGM's, which have had so much development emphasis are one-on-one weapons and will not

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/116/ "New Training Aids," by Col. S. Kalinovskiy. Source: Military Herald No. 7, July, 1975, pp. 103-104.
/117/ United States Military Posture for FY 1978.

prevail in the low ceilings and low visibility conditions in Europe or against the Soviet mechanized forces at night. TOW, an extremely accurate antitank guided missile, was developed as an infantry "portable" weapon to be fired against tanks at long range by troops in the open, that is, with no armor protection. To use TOW this way the shooter would have to be able to see perhaps 3000 meters or more, and then maintain line of sight on the order of 15 seconds while the missile was in flight. Since 1967, and even before, the Soviets, who have an extensive family of PTURS, have been developing the doctrine of defeating PTURS with smoke, using combined arms tactics where supporting artillery takes possible antitank firing positions under fire with fragmenting rounds, by cracking off chemical munitions overhead, and even the use of nuclear weapons. Since all of this was clearly laid out, it would have been prudent to take a systems approach and push technology in order to go directly to a credible missile for war-fighting under these demanding but realistic conditions. Do this rather than evolve the missile methodically through the following sequential steps: day, night, smoke and low visibility, jamming; man-portable, vehicle carried, armored vehicle protected (M113); possibility as a next step, armored vehicle with NBC and night capability. Soviet field exercise tactics in 1962, 15 years ago, could defeat today's TOW and TOW is a marvelous example of western technical sophistication.

Rattling nuclear weapons, threatening their use, and professing the resolve to do so while estimating that the Soviets will not be up to a similar resolve is not, by itself, credible. There must be a balanced NBC war fighting capability, not simply nuclear weapons and the means to shoot them. The most specific example of a war machine essential for the actuality of NBC war is the washdown, decontamination, and sterilization equipment like that of the Soviets which was described earlier. Without such equipment you cannot fight a NBC battle and win. Just the weapons and the capability to cause havoc has little to do with the actualities of nuclear land battle; it is not credible.

Distaste for chemical and biological weapons and national policy not to use them until they are used against us is also not a credible war-winning or deterrent posture. It yields too much of an advantage to an enemy that may well be enticed into the adventure of a quick attack through Europe as our military capability and national resolve continues to erode. For example, Warsaw Pact forces could suddenly attack with nerve gas using aircraft, artillery, and SSM strikes against forward defense positions; command, control, and communications, centers and headquarters; and against air fields and nuclear storage sites. They could then move swiftly in their sealed tanks and MICV's with just the Warsaw Pact forces already in place augmented by a practice mobilization just as they did before the invasion of Czechoslovakia (a practice call up of East German reserves is scheduled for May 1977. This call-up will use a code word broadcast on radio and television, a new procedure intended to make mobilization more rapid and to yield less warning)./118/ Some authorities project that an attack like this could take Europe in less than a week. Once accomplished, the situation is likely to be irreversible and the United States will be looking at a strategic nuclear war

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/118/ Washington Post, March 9, 1977, p. A13.

or the acceptance of what was done.

Since the national attitude of allowing the enemy the first blow is not likely to change it becomes all the more necessary to have an NBC war fighting capability in being; immediately ready capabilities to meet all the actualities of mass destruction, continuous combat warfare; a credible capability for the actualities of NBC war and not a few spikes of high technology.

This means gaining an equivalent or superior NBC capability to that described in Soviet military writing and, more significant, manifest in Soviet operational hardware.

These include:

* Protective overgarments, masks, chemical warfare antidotes and neutralizing agents, anti-radiation sickness pills in total issue to combat and support forces; redundant issue as part of combat and combat support vehicle accessory equipment.

* Automatic CBR alarm systems.

* Complete mechanization of combat and combat support forces that will enable troops to fight from inside an armor protected high mobility box which can be sealed against NBC contaminants.

* A complete family of decontamination, sterilization, and washdown equipment, the doctrine for their use, and sufficient practice so that the equipment is assimilated into easy operational use.

* Medical support vans, armored and with the same environmental systems that will enable them to operate under high intensity, NBC battle conditions at the same pace as the combat units that they support.

* A complete family of chemical smokes, smoke weapons, and generators: variable density aerosol generators, screening smokes, opaque one-way smokes, protective anti-batericide and anti-chemical smokes, smokes for protection against nuclear weapons, smokes to create deception, confusion, and present the illusion of decoy forces, smoke capable of screening IR and even certain radar target acquisition devices. All combat vehicles and even combat support vehicles might be given an integral smoke capability.

The toughest aspect in gaining and presenting a credible war fighting capability lies in hard, tough training, and psychological conditioning. Modern technology has the potential to project and simulate combat and a realistic training environment. The limitation seems to be in allocation of effort (money) and in cohesive continuous combat doctrine that can enable equipment, and technical development as well as realistic training to proceed in concert.

There should be no illusion that technology can, by audio-visual simulation, however advanced, allow troops to train in air conditioned theater seats. In this "era of computational plenty" extraordinary realism and therefore excellent training and psychological conditioning can be coupled with hard, tough exhausting field training. This could be one of the most demanding challenges with the highest potential for improving combat capability.

In most cases matching the enemy with equivalent or improved equipment one-on-one is not the most effective way to achieve a balance. The answer to 40,000 tanks is not 40,000 tanks; or 20,000 air defense weapons is not a matching 20,000 air defense weapons, and so on. However, in the case of the equipments listed above, because of their fundamental nature to meet the actualities of modern combat, there aren't many clever alternatives. Wash down equipment is fundamental. Smoke is fundamental. The capability to seal the crew's compartment and to filter the air is not only fundamental but is essential in operational equipment now and not when the new generation of combat vehicles will get into inventory.

Sokolovskiy presents the thesis that in a modern war land combat forces will be completely mechanized and troops will fight while mounted with dismounted combat a rare exception. If this is so, and the trend is certainly in that direction, is it feasible to consider an entirely new kind of combat uniform? In many cases where man becomes part of a machine as a total weapon system, a special uniform was developed; for example, the aviator's G-suit and pressure suit. Instead of a rugged uniform designed for foot soldiers, fox-holes and field use, one designed for fighting inside a machine or in a contaminated environment when forced out might make sense. It might be close fitting for comfort and to eliminate snagging on equipment, made of a material that would only breath out but was impervious to contamination from outside. It could be made fire and heat retardent so as to allow escape from a burning vehicle. The suit might also be highly reflective to nuclear flash and thermal effects. Critical areas of the body could be protected, at least to some degree, from radiation. Modern "bullet proof" materials and ceramic armor techniques could provide protection for vital body areas from fragments while outside the vehicle and spalling while inside. Instead of a separate, cumbersome mask, perhaps a visor could slide into place and breathing come through a compact, integral canister, perhaps a compact backpack. An umbilical connector could permit plug-in to the combat vehicle's air conditioning for positive pressure and cooling. A very important consideration that could be incorporated in this kind of an advanced technology combat suit, would be the provision for screening out noise and yet permitting a comfortable and an acute level of hearing to a soldier, both for radios and for sounds around them. The noise inside combat vehicles and from weapons that are being fired causes, at the minimum, a temporary loss of hearing and various degrees of permanent damage. Beyond this, constant loud noise is debilitating, causes a loss of efficiency, and can even cause physical illness. The combat helmet in the concept described could be made to block the normal very delicate aural channels and perhaps transmit through the bone those sounds that are essential for combat effectiveness. Low level sounds that must be heard for survival could be

enhanced, while those that are fatiguing and destructive could be screened out. Sounds at intensities that might cause damage could be blocked out almost entirely./119/

Projecting even more demanding technical goals, the same kind of enhancement and protection could be given to the eyes. The viewing device incorporated in the combat suit might provide normal vision, enhanced night vision, subdued and filtered red for interior seeing, and of course, be automatically variable in density as a function of light intensity. The visor or goggles capable of doing this might also couple into the weapon and vehicle control systems in the manner of a pilot's heads up display.

All of this is "doable", probably within reasonable cost, by extending already developed NASA aviation related technology.

/119/ A report that projected various degrees of auditory damage caused by firing various weapons estimated that a soldier that fired a Carl Gustav antitank weapon would be deaf for life.

12. Technology Impact

12.1. The Panacea/120/

> "In the United States, technology has often been seen as a panacea [which could] offset superior numbers with quality. NATO has sought technical solutions to its conventional inferiority. However, the Soviets are similarly armed and where there is two-sided use of technology there is no advantage."
>
> "Real dividends in new technology are not being obtained largely because it is being used to improve existing operating practices rather than seeking new ways of applying military force in which technology can be used to its full advantage. New technology should be seen as releasing restraints upon present operating practice rather than, as now, being constrained by them."

It has always been the innovative military thinker who, by imaginatively using technology equally available to his adversary, gained enormous advantage: Guderian's use of the tank in high mobility offensive action (the Blitzkreig) rather than as a mobile pill-box in support of infantry on foot as was done in the Battle of Cambrai in WWI; King Fredick William I sponsored the development of an iron ramrod which, when exploited by training, permitted an increase in the rate of fire of the Prussian infantry. This innovation, as well as those of Frederick William's son, 'Frederick the Great', also an imaginative military genius, were exploited to make Prussia a great power and to change permanently the balance of power in Europe./121/ The Soviet doctrine of the continuous offensive is a modern example of breaking with existing practices, those of the last war, by the innovative use of available technologies.

12.2. The Competition

The technology and the research and development of United States and its NATO allies are being applied competitively without the direction that a common doctrine would permit. Consequently, while more money is spent by the nations of the NATO alliance on military R and D, less combat capability results.

Big weapon system competitors come readily to mind. The French Mirage, Swedish Viggen and F-16 aircraft; the Rapier, Roland, and Crotale air defense systems; the French AMX, British Advanced Chieftain, German Leopard II, and U.S. XM-1 tanks. Even worse is the incompatibil-

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/120/ A number of the points presented in this section on technology impact were derived from, "The Alliance and Europe: Part IV Military Doctrine and Technology," by Steven Canby, Adelphi Papers Number One Hundred and Nine, The International Institute for Strategic Studies, London.

/121/ "Historical Trends Related to Weapon Lethality," is October 1964, Historical Evaluation and Research Organization, Washington, D.C., DDC 458760, pp. 39-40.

ity of agreement on such basic issues as suspension lug spacing of air to ground weapons and even on IFF.

The ideal would be for a NATO alliance aircraft to be able to land on any airfield, even dispersed bases, and be loaded out immediately. However, since bombs are not only carried singly on aircraft pylons but, also, on multi-store carriers which can be mounted on the same pylon, the problem has to cover three areas: the bombs themselves, the bomb carriers, and the aircraft pylons.

The major cause of lack of standardization is the immense variety of weapon suspension standards of the West. NATO has attempted standardization on 14 inches but there are many hundreds of single suspension aircraft and many thousands of single suspension bombs. No attempt has been made to discuss the additional complexities introduced by the variety of multiple bomb racks and special wiring requirements of the many guided missiles and PGM's. All of the above, lack of standardization and interoperability is an easy way to lose an intense, fluid, continuous combat war. This is simply an example in the aircraft weapon area. The problem is extant throughout NATO. Because of the monolithic nature of the Warsaw Pact combat forces, which are, of course, Soviet dominated, their interoperability problems are much less.

This lack of agreement on even the most fundamental issues extends throughout the NATO weapon system acquisition process and is particularly grievous in research and development where the countries of NATO spend much more to get much less than the Soviets.

The obvious answer is agreement on standardization and interoperability, on sharing manufacture, and on apportioning advanced technology research and development by some criteria such as capability or on the basis of a member nation's peculiar need. However, this is hardly done well among the services let alone among the nations of the NATO alliance.

The problem has been recognized and many horror stories have been written about the overall loss in combat effectiveness caused by this competition rather than cooperation. However, unless this major problem is gotten in hand, as the impact of technology has ever greater significance on modern combat effectiveness, the West will remain on a lose course.

The obvious solution, of course, is to recognize the problem, understand its dimensions, and assemble a multi-national committee to meet and come to a common agreement. Some progress has been made in doing this but it is probably true that each nation will make a gesture on some issues of least consequence but resist and apply whatever pressure that it can on major issues. Agreement by committee is a typical bureaucratic solution with little chance of practical success.

A potential solution that might merit study by ARPA would be to see what might be accomplished if the United States unilaterally established an optimum NATO research and development program and then started its implementation by example. This country, since it provides the major

budget, and has (or believes that it has) a major lead in technology, could establish a well conceived complementary and dovetailing program as opposed to the present competition then proceed to make it work. The others might follow if it made enough sense.

The Leopard II/XM-1 Main Battle Tank issue might serve as an example. It is probably true that there is not that significant a technical and combat effectiveness difference between these very advanced tanks. It is probably also true that no one will ever sell the Germans a tank since this is an area where they feel they are most expert.

Is it conceivable that an alternate vehicle to the tank would provide a better overall modern combat vehicle balance in the NATO forces. A very high mobility -- land, water obstacle, air transportable -- tank destroying and extremely offensive battlefield weapon. In many ways it would better suit U.S. interests. We are best at fire control and guidance. It is the tank that gets the first hit anyway that wins, not the heaviest or best armored. Since we are committed to a defensive posture where every advantage of hiding in terrain will be taken, a tactic suited to defense, armor per se may not be all that critical beyond that for fragments and proliferation battlefield weapons up to a reasonable energy level. Mobility to move in response to Soviet probes and air mobility thrusts would be more important than being a land battleship. The German's could then be allowed to build their tank, which they will anyway. A percentage could be made here in the United States to keep such military manufacturing specialty techniques, like making heavy castings, busy. Meanwhile, a truly advanced offensive vehicle -- light, advanced metallurgy, liquid propellent gun, high technology fire control, swimming, night and weather capable, highly survivable using active and passive measures like variable density smoke, active and passive decoys, missile screens, and above all high maintainability -- could be developed. This advanced concept vehicle would be designed specifically for continuous combat nuclear, chemical, and biological warfare. It would not be an advanced tank in the higher, faster, farther sense but be a new vehicle type that would permit innovative application by imaginative military minds like Guderian, Fuller, Forrest, and King Frederick William I of Prussia, to gain enormous advantage over their conventionally equipped enemy.

The antitank guided missile family is another example where the difference say between HOT and TOW may not be so critical as the fact that neither could defeat the anti-PTURS tactics that were being developed and practiced by the Soviets in 1962, before these weapons were operational. Later generations of these weapons will have more capability but probably so will the Soviet tactics and countermeasures. Would it have been more desirable and cooperative to let Europe build the HOT, meanwhile to project how this weapon could best be used on the modern, sustained combat battlefield, and jump ahead to advanced research and development that could take the European developed missile and launcher and mount it in light all-terrain, armored vehicle with an advanced all-weather target acquisition and fire control system. Thus, the programs would dovetail and complement, not compete, and a weapon suitable to the modern battlefield and not a clear day test range would be developed cooperatively.

Fundamentally, the approach suggested is predicated on leadership and example rather than "motherhood" and agreement by committees of bureaucrats whose motivation will always be to get the most for the country that each represents. If this natural order of things is not followed and a selfless idealist happens to be assigned to a committee, he will soon be replaced.

12.3. Continuous Land Combat Research Programs

There are at once no programs specifically directed to continuous land combat and, in a sense, virtually all programs that are concerned with mobility, command and control, battlefield integration, and night combat will contribute to the capability for sustained modern combat, but not by initial design or intent. On the other hand, since combat effectivenesss derives from the synergistic combination of doctrine, organization, equipment, training and technology with modern combat doctrine as the key or driving element, and since there is no clear NATO doctrine for continuous combat, research and technology has an impact on the capability for continuous incidental to its contribution to some phase of non-continuous operations.

Programs that can be considered specific to continous combat are those having to do with continuous maintenance of equipment, continuous resupply, continuous medical and human factors support, TOE's and tactics that will provide for crew relief and for continuity of command. Also specific to continuous modern combat would be high mobility programs -- on and off road, unaided or little aided water and battlefield obstacle crossing equipment, and advanced logistics and maintenance support.

The character of combat will be confused, the more so because beyond the "normal" confusion -- high intensity of combat activity, no clear lines of demarcation, deep armored thrusts, air mobility assaults at night into the deep rear -- the Soviets are openly committed to enhancing that chaos and confusion to their advantage. They have developed decoy forces, such as angle iron targets covered by smoke, and have a long history of successful combat deception (the Belorussian campaign, for example).

This area of combat deception was a particular skill of the Allied forces Europe in WWII, particularly of the British. In Operation Overlord in the Normandy campaign, decoy air mobile assaults were made using "dolls" and parachutes as well as communications deception to make the drop appear real. This kind of deceptive warfare is particularly effective in making up for inferior numbers; a problem the Soviets don't have but we do. It is also suited to many of the ARPA and DoD research programs. RPV's are already being considered for diluting the Soviet air defenses. Completely believable air landed, air dropped, and amphibious forces could be fabricated using advanced technology methods and applications. However, to be believable, they would have to be matched by actual offensive small unit action forces that could and did operate to create havoc in the enemy's rear. The characteristics of such a force would be high mobility, night and weather capable, very effective against tanks, mechanized equipment, SAM's, nuclear weapons and command

and control centers. All of these, it might be noted, are capabilities of the Soviet airborne Motorized Rifle Battalion. NATO, and particularly the U.S. in the lead role, could develop small unit action forces, highly mobile, capable of creating havoc and destruction by highly offensive action in the enemy's rear. Then, having established and made credible such an offensive force, each unit could be multiplied by three or more fold by decoy forces to which the Soviets would have to respond.

12.4. High Impact Programs

What has been said before but is repeated here for emphasis is that the primary threat to U.S. national interests is that of a Soviet continuous offensive attack through Europe, perhaps with little or no warning. Such an attack will be without let-up, day or night, in any weather, and capable of overcoming any obstacles. We have not organized or conceived modern combat doctrine specific to such an attack. Worse, we are very deficient in a true warfighting capability, particularly for nuclear chemical and biological warfare. These weaknesses have not gone unnoticed. The panacea of a revolutionary breakthrough in technology is not likely particularly since most research and technology efforts are more evolutionary than advanced, "higher, faster, farther, better" weapons rather than technology specific to key enemy capabilities viewed from a systems perspective: a new tank to defeat the Soviet T-72; a new F-15 to meet the more numerous Soviet aircraft threat. Perhaps the best example of technology expenditures that are not specific to the threat is the clear air mass dependent PGM's into which so much effort has gone. It is not enough to justify such efforts as an essential first step to later generation equipment that would be useful. Why spend money for equipment that is dramatic on a desert test range or in a laboratory environment when it will not work in the actual battlefield environment, especially when that environment is easily defined because the enemy has defined it for you, not only in his military writing and his exercises, but in his equipment as well. Area weapons that are capable of terminally homing on large formations of military equipment would be much more useful and specific to the European environment than one-on-one PGM's.

Even more damaging is the diversion of effort from "high impact" continuous modern combat problems which appear mundane as advanced technology research when compared to scientifically novel research. Its difficult to cite a specific example without "goring a pet ox" but, consider as a question and not as a recommendation, would the defense or attack of satellites by say lasers have a major impact on a lightning continuous combat Soviet offensive through Europe? Perhaps some warning would be lost but an attack could be made from a standing start using exercise test call-ups of reserves like the Soviet's did before they invaded Czechoslovakia. Communications, reconnaissance, navigation are all important and can be provided by satellites but if the weapons for war-fighting are not on the battlefield, or are not manned for planned relief when the crew is fatigued, and there is not the training, the technology, the equipment, the organization, and the doctrine for sustained combat, it probably makes little difference whether the satellites stay in orbit or not. In another area, research towards keeping sea lanes open won't help if the Soviet's make their continuous attack

through Europe successfully. The conquest would likely be done in the eight weeks it takes to get the supply lines full. It seems doubtful that the United States could take Europe back without resort to strategic nuclear weapons and it is a moot point whether anything would be accomplished beyond suicide in resorting to that extreme.

All of the novel, exciting and advanced technology sophisticated research programs are, without any doubt, essential but they will not necessarily have a high impact on combat effectiveness given that continuous combat operations in Europe is the key threat that Soviet doctrine and their alarming equipment buildup indicate that it is.

Advanced research effort should be allocated to those problems that will have the highest impact on combat effectiveness. As a research topic a laser or a proton beam is exciting when compared to an advanced technology combat vehicle or a high reliability weapon system for continuous combat. But, as a case in point, the Israelis turned around more than 2,700 damaged combat vehicles in the 1973 Yom Kipper War; more combat vehicles than they had. This was done by highly skilled forward maintenance. Suppose that the forward maintenance teams were capable only of tagging and sending combat vehicles back to rear base and depot maintenance. The outcome of the war would likely have been very different. Suppose, on the other hand, that the combat vehicles were built, not as they have evolved from the civil automobile and tractor industry, but as a new advanced technology "no holds barred" vehicle for modern warfare and not the civil economy. It might be noted that it takes longer to change the engine on a truck than on a modern jet aircraft. An F-5E, for example, has quick snap open doors to get at the engines. Fittings disconnect easily and positively. The engines slide out. Without getting into specific details, the rationale is presented that maintainability might be the key factor in modern combat that could lose the war. Mechanization of the modern combat division is astonishing and the trend is not likely to reverse. For example, there are about 4,000 vehicles of all types in a Soviet mechanized infantry or tank division of about 12,000 men; one vehicle for every three men.

With that ratio of vehicles to men even such actualities of combat as power generation may offer an opportunity for enhanced combat effectiveness. War, even an active war, is largely waiting but at the ready. All environmental, communications, and surveillance equipment presents power demands that are met today by battery and motor driven generators, usually the combat vehicle's main engine. A direct chemical conversion cell might be a high impact technology contribution to continuous combat effectivenes from this most ordinary and yet most demanding combat actuality.

The entire area of a credible warfighting capability in continuous nuclear, chemical, and biological modern combat is open for imaginative and innovative research support from the matters of psychological conditioning and training to protective garments and decontamination. Counter reagent smokes can be cited as one interesting area.

12.5. The Assimilation Problem

All of the above considerations notwithstanding, there is another major problem in actually achieving improved combat effectiveness through technology and that is the assimilation problem, the complete integration of a new weapon system or technology to the point where it is easy and familiar to the combat soldier and it is assimilated into everyday tactics and doctrine rather than for special operations. At first glance, this appears to be an easy problem and this may be why it is often overlooked particularly by technologists who are dismayed to see their sophisticated systems discarded when battle is imminent.

The report "Historical Trends Related to Weapon Lethality" documents that even under the most favorable conditions the most optimistic time between the appearance of a workable prototype and its assimilation -- it's easy and familiar use -- is on the order of twenty years./122/ Preconditions for assimilation are:

* Imaginative, competent, knowledgeable leadership,

* Effective coordination of a nation's economic, technological-scientific, and military resources,

* Opportunity for evaluation and analysis of battlefield experience./123/

The three stages in the development and integration of a new technology or weapon system are:

First	A workable prototype.
Second	Its acceptance by the combat forces.
Third	Its assimilation where it becomes familiar and is in easy use.

It turns out that the prototype is the easiest to come by. A useful and practical breech loading rifle was demonstrated to the British Army in 1776. It was invented and developed into a useful weapon by a Major Ferguson. Yet it was almost a century later that the breech loading rifle was used in combat and then by relatively few Union troops in the American Civil War.

Nor has the technology explosion of the twentieth century speeded up the time between prototype and assimilation. There are countless horror stories about intrusion devices that did not detect and night observation devices that were not focused. These devices obviously passed their laboratory tests, they were accepted, but they were not assimilated.

/122/ "Historical Trends Related to Weapon Lethality," 15 October, 1964, Historical Evaluation and Research Organization, Washington, D.C., AD 458760.

/123/ Previously cited, p. 52.

Soldiers and their leaders are notoriously conservative and have a distrust of advanced technology that has been well earned by the deplorable performance of advanced technology equipment that they did not want anyway and which performed as poorly as they expected that it would. The Soviet soldier is undoubtedly just as suspicious and just as conservative. The difference is that he gets the equipment in his hands to evolve progressively through use in operations into a useful piece of battlefield hardware. The combat forces are part of the Soviet advanced technology development process.

Getting equipment out is resisted in Western development presumably for reasons of economy, so that the equipment, it is hoped, represents a quantum jump ahead not simply an improved model. To pick an example, this may be what is delaying the introduction of land navigation equipment into U.S. tanks and mechanized combat vehicles. Yet, the basic directional gyro-odometer system in universal application in the combat forces of the Warsaw Pact would be a useful tool today, particularly as we become serious about night and continuous combat operations as we must. It seems sad in the most technically advanced of countries that the way a tank commander must get a bearing is to leave his tank, walk 50 meters from the tank, take off his helmet and side arm, then take a magnetic compass bearing and retrace his procedure back to the tank. His Soviet counterpart meanwhile is steering a gyro heading that may have drifted somewhat but is probably still better than that magnetic bearing taken by the U.S. tank commander.

It may also be questioned as to whether the weapon acquisition process that is based on long and repeated study and long development cycles is all that cost-effective. There have been enormous errors made even after long study and laboratory development. The Lacrosse missile was actually assigned to operational units after suitable laboratory development yet it was so vulnerable to any transmissions that it became notorious as the self-jamming missiles and local taxi and police radio operators were asked to stay off the air whenever a Lacrosse was to be fired.

12.6. Summary

What has been said in this section concerning the impact of technology on NATO capability for continuous combat has a number of considerations that must be taken into account. Technology is looked on as a panacea by the West where we can instantly meet the Soviet nuclear, chemical, biological, and conventional continuous offense by a new, exquisitely brilliant technical device; that we can therefore reduce the numbers of men under arms, and divert the budget to more pressing problems with safety; and that we are way ahead of the Soviets in technology. Somehow we must be disabused of these notions because not one is true and worse, with the pace of the Soviet buildup and the projected rate of advance of a modern continuous offensive, there will not be time to put together an instant, high technology army, termed by former Secretary of the Army Hoffman, as a myth in which we choose to believe. Soviet weapons have been tested against ours, we have had good opportunites to analyse them, and if they are not equivalent, then they are very nearly so. In the context of actual war fighting in a chemical, nu-

clear, and biological environment they are way ahead and its doubtful that we will ever catch up unless we make a determined effort to do so. In military thought and organization to fight a modern war they are also way ahead. Leaning on technology somehow to restore the situation is leaning on a very weak and doubtful crutch.

Granting that technology could yield this enormous advantage, our research and development efforts are largely directed in either higher, faster, farther evolutionary efforts or in esoteric and exciting scientific novelties. What needs most to be done is to identify the key issues in the threat and direct research and development to those problems where a maximum impact in combat effectiveness can be achieved whether they are exciting or not. Part of this has to do with a willingness to depart from current operating practice and to direct effort to defeating the Soviet NBC continuous offensive.

Again, even if all of the above were achieved then there is the matter of competition within NATO as opposed to cooperative and optimum use of an overall NATO military research and development budget. The problem is recognized and efforts are largely centered on committee action to reach agreement; a straightforward bureaucratic solution. What might be done is for the United States to provide leadership and example. A great deal of selfless action and yielding on pet projects would be required. However, it could be made to work and indeed it must be.

Finally, the long process between developing a successful technology and its assimilation into easy use by the combat forces is not understood. Technologists have to accept much of the responsibility for circumventing this long integration period by working more closely with the operational forces. Even more important is advanced military doctrine based a full awareness of the advantage that technology could yield as was done by King Frederick William of Prussia and his iron ramrod. Most of all, there ought to be more evolution of technical equipment by operational units as is done by the Russians. Get the equipment out. This does not mean test and evaluation by special squadrons or test organizations because these quickly become just that -- special. The development needs to be done by the soldiers who will end up with the equipment.

With the above considerations serving as a framework, a number of potential technology solutions and concepts have been presented in the sections of the report to which they apply. In the section on Proposed Research Programs, some of these ideas, concepts, and potential technology developments that appear to bear on problems of continuous land combat as they have emerged in this study are presented.

13. Recommendations: Potential Research Programs

13.1. Introduction

This section presents recommended research programs that have the potential for significant impact on the capability of U.S. and NATO combat forces to conduct and support sustained land combat operations and to defeat the Warsaw Pact threat of the continuous offensive.

It must be understood that there are few recommendations, developments, or research programs that can be regarded as being unique to continuous land combat. As these potential technology and research programs are read and considered, this should be kept in mind. Even the presumption that it is necessary that systems and technologies be concerned with night combat operations in order to be relevant to continous combat is not correct, or only partly correct.

As was pointed out in Section 12.3 Continuous Land Combat Research Programs, "there are at once no programs directed to continuous land combat and, in a sense, virtually all programs that are concerned with mobility, command and control, battlefield integration, and night combat will contribute to the capability for continuous modern combat -- but not by design or intent." They are intended and were established to contribute to "normal" or accepted concepts of land combat. This, indeed, in the sense of effort allocation, is part of the problem. We are way ahead in some areas, but haven't started, even avoided, other areas that are essential to continuous modern combat. To put this imbalance right, the recommendation has been made, and restated several times for emphasis, that the recognition of the problem, and then the development and promulgation of doctrine for continuous modern land combat are essential before there can be concert and balance in the effort toward the achievement of this capability which will evolve inevitably because of the pressure of technology and mechanization. Vital to the issue is that the Soviets have recognized the enormous advantages of this concept of modern warfare and have been working steadily and openly toward it. Therefore, it is imperative that a DoD-wide program be directed to what will be a broad and far-reaching effort which will impact in a major way on every element and aspect of combat capability:

* Doctrine, organization, and deployment concepts for coalition warfare.

* Training and psychological conditioning for support and combat forces.

* The organization and use of reserve forces.

* Human factors (fatigue, endurance).

* Maintenance and performance requirements for combat and support vehicles.

* Field and operational test and evaluation.

* Basic concepts of military equipment design and performance criteria, maintainability concepts.

* The continuity of command.

* Continuity of combat and service support.

* Ammunition requirements and usage rates.

* Air support and dependence on bases.

These are some of the aspects of a major DoD program that will be required to gain the capability for continuous mechanized warfare on the NBC or modern conventional battlefield.

With what has been stated above to establish a perspective, in the sections that follow research recommendations that bear on various aspects of continuous combat are suggested.

Each research recommendation is presented as a separate topic where a problem inherent in sustained combat is identified and then a concept, a method of approach, or a research program area addressed to that problem is described. Many of the ideas and recommendations are based on the technical discussions at the operational and development organizations where the continuous land combat briefing was presented. Others evolved from the study and analysis of documents, reports, and technical journals. Firm conclusions for actions by the services and DoD are contained in the summary which is in the front of the report.

These recommendations are intended to provide a basis for selective development a requirement of the task assigned. They are not presented in order of priority except for the first item, that of continuing the study of continuous land combat. The work thus far has confirmed that the impact and the implications of continuous combat are as far reaching and as fundamental as was anticipated. This is not sufficiently recognized, understood, or acknowledged in any way that is commensurate with its importance, except in Soviet military writings and doctrine. This disparity and its consequences are difficult to overstate.

13.2. Augmented Support of the Continuous Land Combat Study

The ARPA Military Operations in Built-up Areas (MOBA) programs provides a parallel and a precedent for what can be done and the impact that an ARPA study can have. Urban combat is a key section of the new capstone doctrinal manual FM 100-5 "Operations"; every staff has an urban warfare officer; all new weapons and equipment are reviewed as to their MOBA combat application and limitations. This SRI/ARPA study is an initial step in a little understood, more extensive and tacitly avoided problem area. Because of the critical significance of continuous combat operations, the scope and dimensions of the ARPA continuous combat effort should be on the order of the MOBA program with similar perspectives and objectives.

The problems in gaining the capability for continuous operations are so broad and the impact and implications so fundamental that they will not, and indeed cannot, be met until basic and firm doctrinal and policy guidance is provided by the decision level of DoD and the Department of the Army. This will be done when the problem is recognized and acknowledged and when sufficient effort is made to understand its fundamental and far reaching implications.

The ARPA programs can help by providing additional substance and support to the understanding of this many dimensioned problem. The fundamental nature and significance of continuous combat lends itself to the "most impact for the research dollar" criterion that is sought in ARPA programs.

Said another way, if the Soviets can implement their continuous offensive for which they are organized and equipped, then their objectives will have been accomplished and it will probably be irreversible./124/ Therefore, research directed to other problems, while unquestionably important, might not have helped in meeting the primary threat.

13.3. Advanced Concept Military Maps for Field and Urban Applications

Continuous, highly fluid modern combat will place a high premium on having the most current, accurate, and useful information on the battle situation. Fundamental, of course, is the topography and terrain characteristics of the combat area. The information should be in the most useful format, scale, and content for the specific user, whether it be a patrol leader, a tank battalion commander, or the tactical commander at the CP or higher headquarters. Soviet maps, while less widely distributed, are considered to present information more specific and useful to land combat [See "The Map Gap," Lt. Col. Walter H. Parsons III, ARMY, August 1976, pp. 37-40.] Maps for urban combat present a special set of problems.

A number of advanced technology developments can be coupled in meeting these problems. Advanced computer-based techniques for data handling, storage, transmittal, and selective format hard copy retrieval, could be used to achieve the following:

* Eliminate the need for the enormous numbers of hard copy military maps which, in addition to their costs, logistics, handling, and distribution problems, are perishable and get out of currency quickly. All the information essential to map production could remain in storage. Update could be literally continuous. The technology of multicolor, variable format hard copy production is well along and could be extended for this military application.

/124/ Except perhaps for all out strategic nuclear war. But here also there are clear indications that the Soviets are better prepared particularly in matters concerning survival of the civil population.

* A 1/50,000 scale has been established for U.S. military maps. Other scales are often useful./125/ A reconnaisance patrol has a relatively small area of focus and needs detail. The advanced concept that is projected could provide variable detail and scale on demand.

* Night combat requires emphasis on different features of the terrain, obstacles, and structures as well as a change in readability; colors for red light contrast and reflectivity.

* U.S. forces are usually fighting alongside allied forces who use a language other than English. The hard copy output can be presented in different languages with appropriate programming.

* While the term "maps" has been used in the description, the output is not necessarily a map in the folded paper sense. For tanks and combat vehicles and helicopters, particularly those required to fly NOE altitudes, a video cassette might be practical. Weapon system compartments are cramped and the crew's hands and minds are heavily occupied. In motion, bouncing and vibration problems make map handling awkward. Reading maps is particularly difficult at night. The video cassette map could be coupled into the navagation and sensor package of the vehicle, perhaps even allowing a moving display.

* The capability for adding information on enemy forces, disposition of own units, and specifics of individual unit mission and assignments can be readily incorporated. This is particularly important in a high intensity, fluid, battle situation at night and in bad weather where coordination is difficult and important. In the cassettes for major combat vehicles, aircraft and helicopters, the combat situation could be updated via data link after the cassettes had been issued and the combat in progress.

* At command posts and headquarters the advanced mapping computer output could provide, on selection, video output either by cassette, disc or other imagery and storage system. A format compatible with battlefield display projection systems where details are suppressed for overall situation clarity and symbols are used.

* It would not be necessary to have a total system at each major command level. Output terminals could be fed from a central (or several central) computer facilities. The output terminals could also have reduced capability (hence lower cost) according to the requirements of the combat units supported. Transmission might be by land line where possible, or by secure high capability data link using other ARPA sponsored technology.

/125/ Lt. General Donn Starry, Commander V Corps, considered the 1/10,000 photographic enlargement of standard military maps of his corps area that were made by RAND to implement a terrain study so useful that he requested copies made for his headquarters use.

* There would be a special pay-off in urban warfare. Cities change rapidly. Little serious attention has been given to maps specifically for urban combat. Historically, gas station road maps (Michelin) have proven to be useful but makeshift alternatives. Information peculiar to city combat could be incorporated and kept current more easily than hard copy update. Selective scale and information retrieval might go down to subsections of the city since urban combat is often fought block to block. Some examples of data specific to city combat include:

- Principal gas, water, and electrical conduits.

- Sewers (particularly when they are trafficable).

- Weight bearing capability of roof structures (for helicopter use).

- Communication nodes and netting.

13.4. Cheap Terminally Guided Sub-munitions

The Director of Research and Engineering, Malcolm Currie, stated the requirement for a really effective area munition, adding that one approach that holds promise is the terminally guided submunition, but the concept would have to be low in unit cost. After seeing the low visibility environment and rolling terrrain of Western Europe he expressed reservation about the effectiveness of precision guided munitions in which so much research, development, and procurement support has been expended.

The development of terminally guided, low cost, area sub-munitions, scattered or better, delivered in a pattern over a wide area where there are large number of tanks and weapons of war should be aggressively pursued. Delivery can be effected by several methods and vehicles. High performance aircraft, artillery, SSM's, RPV's. Remotely piloted vehicles would be particularly useful because they could be in the hands of and directed by the land combat forces. Zero length launchers and a basic propulsion and guidance system like that of the simple German pulse jet V-1, updated to today's technology, would be useful. Survivability of a delivery system is always an important consideration particularly in the lethal air defense environment that the Soviets can establish and move with their forces. However, if costs are low, large numbers of vehicles and sub-munitions can be expended with the exchange advantage on our side; that is, it may cost more overall/126/ to shoot them down and many will get through anyway.

/126/ Not just in dollars but in using up the ammunition of the air defense weapon that is part of and protecting the mechanized infantry combat vehicle formation.

13.5. High Mobility Tank Destroyer

Tank destroyers vice a superior tank: It has become an axiom that it takes a tank to kill a tank. But an improved tank, like the XM-1 is probably not significantly better than the Soviet T-72 which has already started to appear. In a tank vs. tank shoot out the effectiveness of tank guns -- like the Soviet 122-mm, 5400 fps tank gun, the German or British 120-mm gun, the standard 105-mm with its improved antitank munition, and the ARPA 75-mm rapid fire antitank cannon -- it is the tank that gets the first hit that wins./127/

If this is so then tank battle has become a gun-on-gun matter and armor beyond that required for protection against artillery fragments and so-called battlefield proliferation weapons may be all that should be used. Effort can then be directed to guns and fire control that enhance gaining the first hit. Armor can be traded for mobility, and smaller size.

Mobility is a key factor in modern mechanized land combat. High mobility is often equated to improved survivability because it seems logical that it should be more difficult to hit a faster-moving target than a slower one. This aspect of improved mobility will be further investigated by the ARPA HIMAG tests./128/ But even more important is the mobility necessary to get where you should be or out of where you should not be. Modern tanks are so heavy that they have about reached the weight limit capacity of bridges in Europe. Without bridges, steep-sided canals and waterways, with which Europe is laced, presents obstacles that cannot be traversed by tanks without considerable equipment support. This can affect high mobility, fluid battle situations, whether attack, withdrawal, or getting to another position is necessary. Tanks have become so large and so heavy that they present a major air transport problem.

Other considerations are:

* A light vehicle could swim and be air transportable by helicopter or by intra-theater transport.

* Wheels, or perhaps some NASA derived variation, might be used instead of treads which are low reliability, high cost, high vulnerability items.

/127/ Accepting that a mobility kill or better is enough to win the engagement and accomplish the objective of stopping the attack (of that tank).

/128/ Some light on the question can be extrapolated from the CDCEC tank gun vs. helicopter tests. The tank gun was found to have a very significant Ph against a helicopter target until a velocity transverse to the line of sight greater than 35 knots was achieved. A ground vehicle, however agile, would have difficulty reaching speeds like this, especially in combat where they are likely to be in a head-on aspect.

* Lower power requirements mean a lower military signature and lower POL requirements; logistics will be critical.

13.6. IR Eye Tracking for Training, Stress Limit Testing, Shooter Selection, Other

There are many very difficult human factors problems of training, stress measurement, and personnel selection that are addressed by cause and effect empirical methods. Many aspects of continuous combat are dependent on personnel selection, training methods, fatigue and stress limits, psychological conditioning, and on such imponderables as why one person can aim and control an expensive guided weapon while another, apparently equally qualified, cannot. These are not a new set of problems brought about by the necessity to gain the capability for sustained combat. However, the squeeze on the defense budget, the high cost of advanced guided munitions, and the clear indication that a short war will not allow "on the job training," that is, selection and learning in the course of experience gained in long campaigns, lends urgency to concepts that may have an impact on the difficult human related aspects of the problem.

The use of IR eye scanners and eye trackers has come a long way. Basic laboratory models have demonstrated that the stress level of a subject can be detected and measured. The immediate association and response to word, thought, and printed material can be correlated by tracking eye movement. How a subject reacts to instruction, his scan of control instruments, what he does in his thinking and weapon control process as betrayed by his eye movement can, it is suggested, be used to more efficiently measure stress, train, select, and achieve optimum operator effectiveness of weapons and vehicles.

It is not a new idea that correlation of eye movement and scan can be used to measure an operator's capability in difficult and stressful machine control situations. Camera correlation techniques have been used to study the scan of the instruments used by pilots flying aircraft under instrument conditions. The cameras record the eye scan and the time. It is necessary then to calibrate the eye direction of look with the physical lay-out of the panel. Then the flight path and condition of the aircraft (or simulator) must be correlated. All this takes place well after the fact and is time consuming and laborious.

An IR tracker might be used to gain a similar insight into what an operator -- a pilot, driver, gunner, loader, tank commander, a radar operator under EW jamming stress -- is seeing; scanning. When he loses control or starts behaving ineffectively, this can be determined in near real time, by means of available eye tracker microprocessors, and computers that are capable of using the advanced learning techniques of artificial intelligence. This is the concept that is suggested.

Teaching and training methods can be directly measured after enough is learned by computer based eye tracking methods. This is the reverse side of what has been discussed above. Said another way, measuring what a good operator or shooter does can then be used as the basis for training emphasis.

There has been a great deal of interest in the capability of the driver and the crew of combat vehicles to perform effectively in high speed, high agility, cross country travel. Methods to date have been largely empirical: set up a rough country test track; specify a series of tasks; measure how effectively the tasks were done after the course has been run. Then increase the severity of the tests and do it again until limits are reached or can be extrapolated. This is clearly time consuming, expensive and clumsy. It may also be dangerous to the crew and the equipment. For example, in rough course high speed tests, the drivers of the combat vehicles going through those tests have been, on occasion, knocked unconscious. The potential for disaster is obvious. The application of the computer based eye tracker methodology suggests itself. By using data link, when the operator is near his limit can be known in real time and the run stopped or moderated.

There is current ARPA interest in low profile combat vehicles that will require the driver to drive either in the supine or the prone position. The tests could be done efficiently and driver performance measured directly in real time using the methods suggested.

A great deal of research and development costs are expended to get a small increment in operator guided missile and weapon system performance. Yet in TOW firing tests some operators can achieve very nearly the accuracy built into the weapon while others cannot, no matter how much training they are given. This is not a phenomenon peculiar to TOW. In fact, TOW, by design, is the simplest of all guidance and aiming systems; the shooter simply keeps the crosshairs on the target while the missile does the rest. The wide variance in shooter capability is observable in any weapon system where operator aiming and control is necessary. Such operator inefficiency is perhaps acceptable where a rifle bullet is the munition. A very high cost TOW or Cannon Launcher Guided Projectile is another matter. The eye tracker methodology suggested could be applied to learn what makes a shooter (inherent characteristics); to select out those who are not; and to sharpen up training methods and equipment. For example, elaborate simulators have been designed for training TOW operators and these have yielded good results. Suppose that by using the eye tracker computer method proposed here equivalent, or even superior, results could be achieved by simple, low cost methods and equipment. It is not suggested that this would be the case but it illustrates what might be done with the concept.

Other applications:

* Measurement of the stress of night combat and the fatigue of continuous operations (in realistic training, of course).

* Operator stress caused by alternative EW methods. What is best -- brute force jamming, chaff, deception, other.

* Vibration and noise effects.

* Reduction in effectiveness of troops forced to wear protective garments.

* Nap of the earth flying stress in low visibility weather.

* Direct measurement of operator efficiency under various lighting conditions, displays, and control requirements.

All this is being done to varying degrees but the eye tracker, computer based methodology could yield "real time" results, reduce test and experiment cost, and permit fine grain modulation of stress application.

The ARPA program recommended is appropriate to the Tactical Technology Office in that further development of IR eye tracking as a scientific laboratory phenonomen is not suggested, although specific scientific and engineering experimentation would be necessary.

The research program recommended would:

* Establish where eye tracking and computer based artificial intelligence methods could have a primary impact on combat effectiveness. (I have suggested some ideas in this paper.)

* Select those with the highest pay-off as proof-of-concept research projects.

* Develop the equipment and experiments for these proof-of-concept combat effectiveness requirements.

* Identify and support whatever laboratory engineering research that may be necessary to implement the proof-of-concept research and equipment development.

* Should there be discernible promising results, extend the military operations research work in close cooperation with military requirements and R&D organizations and move the program into service R&D and hardware development.

13.7. Precursor Sub-Caliber Round for Closed Loop Tank Fire Control

The Warsaw Pact threat of the sustained offensive is dependent on the large numbers of tanks and mechanized infantry combat vehicles with which their combat forces are equipped. There is, therefore, a great deal of interest in antitank weapons and considerable R&D effort is dedicated to the problem. The tank gun kinetic energy round is acknowledged to be a tank killing weapon of such brute power and simplicity that it can only be defeated by more armor and the practical limits of frontal armor may have been reached.

"In theory, an individual tank crew can observe a round that does not connect and make a range (elevation) correction, but, in actual practice, this procedure is hard to follow with modern ammunition, not only because of muzzle gases obscure the vision of everyone in that tank. Discarding sabot tungsten carbide rounds are even more difficult to spot because they are smaller and faster. It is possible, of course, to observe from another tank, or even from the ground, but hardly practical in battle."/129/

/129/ "Tanks in the Middle East," Joe Weller, Military Review. May 1976, p. 22.

In tank battle it is of paramount importance to get the first hit. Therefore, there has been agreat deal of attention given to fire control: laser ranging; closed loop; burst fire to increase the probability of getting a hit. Closed loop fire control and burst fire yield significant advantages when coupled. A closed loop fire control system includes a high speed digital computer, a means for tracking the trajectory of the preceding round, and then relaying the gun automatically to correct the trajectory of the next round to be fired.

There are some actualities of the projected European combat environment that must be considered when the sustained combat threat is viewed from a systems perspective. The basic load of ammunition in each tank and combat vehicle will be a most important factor. The Soviets place great emphasis on achieving surprise, on concentrating their forces on principal axes of attack, and on shifting following echelons to success rather than reinforcing or salvaging failure. What this means is that those tanks and antitank weapons that are in the path of the success axis will have more targets to service/130/ than they can handle and their basic ammunition load may be quickly expended, particularly if burst fire is necessary. Other important considerations of cost, weight, and complexity also apply and these will be touched on later.

The concept suggested would incorporate a sub-caliber precursor munition that would gain the advantage of closed loop fire control and burst fire yet husband the basic load of main tank gun ammunition. In addition, a simpler therefore lighter main gun is achievable with all the cost and reliability advantages of a simpler system.

The concept suggested is predicated on a co-axial sub-caliber gun with a relatively rapid rate of fire. The round fired by this gun is not intended to have a killing purpose but would be designed to have, within practical limits, the exterior ballistics of the main tank gun round and an enhanced means for feeding back its position on the trajectory to a sensor in the tank or combat vehicle from which it was fired. Signature enhancement might be a tracer or flare material specific to the region of attention of an image intensifier IR target acquisition device, a laser corner reflector in the base of the round, or perhaps a radar reflector if the frequency were very, very high. This feature of the round would depend on the sensor in the shooting vehicle.

The flight characteristics of the sub-caliber round would be aerodynamically designed to be like the main round and would be optimized for that purpose.

The rate of fire would be a function of the rate at which the tra-

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/130/ The term "service" was coined by LTG Donn Starry, Commander V Corps, who is seriously concerned about the number of tanks that each of his tanks might have to engage should a concentrated attack be thrown against his units. Calculations based on total numbers and on time and space considerations, while clearly representing a boundary condition, indicate that basic load and resupply in the combat environment may be critical factors that can effect the outcome of the battle.

jectory monitoring sensor and computer could acquire and assimilate the data and how quickly the sub-caliber recoil could be damped out and the gun realigned. The main tank gun will have been loaded and closing the firing key would initiate the firing of the sub-caliber gun. The fire control computer would be programmed with all the normal fire control parameters and equations. In addition, however, the total concept is based on self-learning to correct the gun lay on the basis of data from the precursor round trajectory and the observed correction achieved with each succeeding round. The system would learn by iteration the effect that computer introduced corrections had and thus account for target and own vehicle motion, wind, temperature and air density effects, and the many variables in the fire control problem that are not only difficult to measure but which literally vary from instant to instant. The observed trajectory of the round will be compared within the computer with the trajectory that it should have had as a function of the fire control algorithms, the data in the computer, target and own vehicle relationships, and the dynamics of the firing vehicle. Correction is introduced for each succeeding round until the trajectory required to get a hit is recognized or projected by the computer at which time the main tank gun is automatically fired.

If the above can be done the direct advantages in optimizing the killing potential of the tank basic load of ammunition is obvious. Even more important is the impact that the concept would have on the battle. Using the main gun rounds to determine "closed loop" errors is an improper use of the limited supply of killing projectiles. In the intense Warsaw Pact battlefield environment each NATO tank can expect to be outnumbered and must, therefore, be able to account for several tanks and combat vehicles. One for one is a lose situation. Rearm in the combat environment may not be possible. The pace of the sustained offensive will be such that reload at some later time will not influence the outcome of the battle or the war.

As the concept is studied and engineered and tests are conducted, it may develop that a burst is best to achieve the kill or affect desired./131/ On the other hand, it may evolve that the concept described could be depended upon to get a hit for each main gun round fired within reasonable engineering limits. All kinds of simplicity, cost and weight benefits would accrue. Auto load would not be necessary or at last simplified in that loading could be done in the shift target interval. An automatic cannon is a complex and difficult engineering achievement. A single shot gun can be much simpler. Engineering (and cost) attention could then be directed to reducing trunnion load and stress take-out structure so as to reduce vehicle weight. Barrel erosion and the very difficult barrel replacement problem would be reduced. In fact, since the main gun would fire only when the gun is on target, higher velocity might be feasible and erosion beyond what is considered

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/130/ As an aside here, an important question that needs to be addressed is what is the effect that should be expected of an antitank round. In a simplistic sense, a total kill is an absolute answer that can hardly be challenged. However, just stopping a tank and damaging it so that major repair is required would do the job, that of stopping the offensive.

to be normal in conventional tank gun practice might be satisfactory. More expensive and lethal main rounds could also be considered. The logistics tail advantages are also apparent.

Using the closed loop fire control concept where the main tank gun round is its own precursor, damping out, resettling, and precisely regaining the alignment of the main gun after each round is fired is very difficult to engineer and to achieve. The energy that must be taken out is enormous. The recoil and jump not only has to be absorbed but damped out and the gun realigned within most demanding accuracy and tolerance limits. Accomplishing the same thing with the sub-caliber gun is also difficult but certainly a much simpler problem from the energy and size standpoint alone. This simplification would also pay off in reducing the cost, weight and complexity of the combat vehicle very significantly. It is important to note that size, weight and cost can be spiralled down as rapidly as they spiral up.

13.8. Cybernetics and Automation for Military Tasks

This is an area that represents a logical extension of modern warfare trends and is particularly suited to the era of computational plenty and the microprocessors that the Western nations, particularly the United States, have developed. The technical man has always tried to wage war out of eyeball contact; as distant as his stand-off technology would allow. While a great deal has been done on unattended ground sensors and on the integrated and automated battlefield, the technology transfer from the NASA space programs, in the handling of hazardous materials in the atomic energy program, robotry and artificial intelligence (self-learning) manipulators and handlers that have considerable industrial applications, and most of all, the explosive growth of computational capacity and microprocessors largely from research in the civil sector, indicate that if technology is to give us an advantage in the continuous combat battlefield, it is in these technical areas where we have leverage.

Studies of the military applications of cybernetics to date have been limited and somewhat theoretical. Conclusions and recommendations, not surprisingly, indicate that automata are particularly applicable in boring repetitive military tasks where humans are likely to dope-off and in hazardous areas -- bomb disposal, clearing mines, and the like. However, because of the pressure on manpower, the larger resources in manpower and money available to the Warsaw Pact, as well as the steep increases in "computational capacity" and a correspondingly steep decrease in cost, it seems appropriate to push hard to exploit this technology. It would be important to stay close to operational reality and the operational problems by sound systems analysis (as opposed to interpreting continuous combat problems from the technologist's perspective) but to stay wide open on how to meet the problem; ready to accept the unorthodox; not to prejudge as to over-sophistication or cost. It is possible to be extravagent in technical complexity so long as it can be implemented in large scale integration, microprocessor chip technology and stay low cost and reliable -- after development is completed. This flys in the face of what operational personnel have experienced so they are justifiably suspicious of sophisticated technology and prefer a

weapon that is as simple and dependable as a club. (Unfortunately, we are dealing with a technically sophisticated enemy.) But, properly developed and engineered, advanced technology weapons, even "robots", can have both reliability and combat advantage.

Smart mines -- inert until it detects a military machine that comes within its kill zone at which time it energizes and moves to its target or directs its killing mechanism at it.

Battlefield resupply -- resupply vehicles, unmanned that can traverse, on demand, to the weapon system, tank on combat vehicle.

Logistics and materials handling -- this area has been identified as a horror story that has not been solved in the last three wars. It seems well-suited to the techniques of automated data processing and automata.

Recovery of the wounded and dead on the very lethal modern battlefield -- there will be no pause and the environment may be lethal -- chemical, nuclear, biological.

Remote control combat vehicles -- could be small, cheap, one-way, throwaway yet do a lot of damage depending on their kill mechanism. They could also be multiplied by decoys which in the heat and confusion of battle can be a major factor. Mini RPV's are being considered for air defense saturation and attack (under active development by the Israelis).

These are only a few and perhaps not the best examples. What needs to be done is to kill many with few, making the maximum use of those technologies where we have leverage, to do it innovatively, but to remain solidly anchored to operational actualities.

13.9. Advanced Combat Vehicle Power Generation

Power generation, as with most combat vehicle technology, is borrowed from the automative industry. It is usually a battery and generator/alternator system or sometimes an auxiliary power unit which also uses the same motor-generator principle. This causes few problems in peacetime because vehicles are used intermittently.

In combat, particularly continuous combat, machines will be in continuous use -- in combat, moving to or out of harm's way, and, most of all, waiting at full alert with all communications, target acquisition, and life support systems on. Waiting, in even the most active and continuous combat, will likely be the usual state of the combat vehicle and crew. This means, with present systems, the main engine will be running periodically using fuel extravagently, loading up, making noise, and creating a large military signature.

It is the combatant who can develop the means to use his vehicles continuously that will gain the advantage (given that he develops the means for crew rotation and support).

All of the above suggests the importance of advanced technology power generation techniques not to mention the reduction on POL supply, a most important factor in continuous combat.

Fuel cells, direct chemical to electrical conversion techniques, thermal battery augmentation, magneto-hydrodynamic methods will merit consideration as well as advanced technology methods that perhaps were not before considered for the prosaic application of land vehicle power generation.

It may not be a problem in intermittent combat; it will be a major consideration in continuous, high intensity combat.

13.10. Chemical Dispersants to "Attack" Combat Vehicles

U.S. national policy does not ascribe to chemical warfare against men. Continuous combat in modern warfare is entirely machine dependent. Is there a useful way to either directly attack, or mark, combat vehicles chemically?

Direct attack might be based on chemical reaction with vulnerable parts characteristic of and essential to combat vehicles: rubber, lubricants, and optical glass. Even obscuration of optics temporarily, say for the period of an engagement, might yield a very significant combat advantage on the modern battlefield between fast reaction, accurate weapon systems.

A chemical aerosol that would react with the metal or paint to enhance or produce a unique target signature could have several advantages. Relatively inexpensive terminally-guided stand-off weapons or pattern delivered weapons could home on an enhanced, perhaps unique, chemically produced emanations. Vehicles in a tree line, in foliage, or covered could be made to stand out. Deception forces covered by smoke could be revealed.

If there were some degree of permanence to the marking, say even 30 minutes, command and control coordination between the designator and the shooter could be more relaxed.

Once marked by this "mark of Cain" system, even getting out of line of sight and behind some protective terrrain feature would be of no help if the homing weapon came down from above -- plunging fire, mortar, air dropped.

13.11. Flat Plate Infinite Focus Mosaics (Insect Eyes) for Combat Vehicles

Continuous combat is possible because of the complete mechanization of land combat forces and the technology that enables movement and effective combat at night and under low visibility and poor weather conditions. The battlefield may also be dominated by mass destruction weapons or the threat of their use. The trend, therefore, is toward machine combat with crews inside where the compartment may be sealed and the environment controlled. It is necessary to see and to perform those

acquisition and surveillance functions necessary for enemy detection and weapon control form inside under all lighting and weather conditions.

Conventional practice is to use optically based systems for light gathering, amplification, aiming, target acquisition, night observation, driving, and other functions having to do with "seeing." These are high cost, skill produced, and fragile articles for battlefield use. They are vulnerable to shock and also vibration creates serious problems which requires gyro-damping. When looking directly through these light concentrating devices, the eye is particularly vulnerable to powerful (laser) light, bright flashes on the battlefield, and, of course, to a nuclear explosion. Optical ports create a sealing problem. Light leaks, even dim red, are also a problem and easily detectable by modern light sensitive target acquisition devices.

"In a night attack tanks perform their missions in closer coordination with motorized rifle podrazdeleniya. This is explained by the fact that at night, even with night vision instruments, visibility from a tank is still limited. The crews experience difficulties in orientation and in seeking out and distroying targets, especially antitank close support wepons, which are most dangerous for tanks at night. Under conditions of darkness it is more difficult for tanks to cross antitank obstacles and natural barriers, and maneuver on the battlefield is hindered. Therefore, it is necessary to have particularly good training and practice for night crews in night operations and through organization of coordination and motorized rifle and engineer podrazdeleniya."/131/

All of the above suggests the use of mosaic panels of infinite focus sensors for selective regions of the EM spectrum. These could be assembled in modules as opposed to a single panel to degrade gracefully losing fine-grain detail with battle damage. Light amplication and filtering could be accomplished electronically; that is, the same scene could be scanned in several wave lengths, perhaps automatically, so as to penetrate camouflage and foliage. The input into a central computer could be electronically stabilized for presentation to the driver, commander, or gunner on a cathode ray or flat plate presentation. Amplication could also be done electronically as well as stabilization and the elimination of vibration. The computer could also be "taught" to recognize threats faster than is possible by human reaction and could display a threat (type/location) symbol, sound an alarm, and even initiate or implement a countermeasure. The "seeing" function of the mosiacs could be coupled with other surveillance and target acquisition clues.

A great deal of work, research and development has gone into flat plate, infinite focus sensor panels for IR, solar power generation, and other applications. All of this might be coupled with high data transmission along glass filaments, microprocessors, high density storage and other modern digital computer techniques to accomplish those functions traditionally, incompletely, and fragilely done by optically based systems.

/131/ The Offensive (A Soviet View)" A.A. Siderenko, Moscow, 1970, p. 203.

13.12. Variable Density Smoke Generators

The entire matter of smoke and deception warfare has lain fallow in the armies of the Western alliance, particularly the United States. This has not been so in the combat developments of the Soviet Union. It was recognized more than 15 years ago that infantry antitank guided weapons -- PTURS -- could unbalance the tank dominance on the battlefield. Smoke, an ancient, very basic and very effective battlefield weapon, together with combined arms tactics, not only restored that balance in favor of tank heavy mechanized forces but re-emphasized the primacy of the continuous offensive and the advantage of night (and smoke).

Among the modern battlefield weapons developed by the Soviets are variable density aerosol generators. This anticipates subsequent generation antitank guided weapons and precision guided munitions that may be able to "see" through certain particle or aerosol sizes.

The use of smokes are documented by the Soviets as screens against air attacks, to cover deception and decoy forces, and as protection, that is, to counteract and neutralize batericide and chemical smokes. Their use in nuclear war to screen against the flash and heat has also been developed.

The Soviet's modified jet engine is worth considering. There may be many advanced technology alternatives. The entire matter of smokes, their generation and tactical use, on modern continuous combat merits a great deal of effort: screen mechanized forces from ground and air attack; block artillery spotting; create chaos; cover deceptive forces; decoy; cover air landings; and make deceptive air landings more believable; for protection -- nuclear, chemical, baterial; to create chemical warfare panic.

13.13. Advanced Technology Marking, Guidance, and Identification

In the modern fluid continuous combat battlefield characterized by large numbers of mechanized forces, rapid and deep armored thrust, no lines of demarcation, an environment of smoke, night, bad weather, confusion because of the pace and numbers of forces involved, deliberately created deception and confusion, suggests that all means for route marking, guidance, and identification will have great importance.

The Soviets have equipped their combat vehicles with red, green, and amber screened formation lights, screened guidance lights, a light on the snorkel, and a family of route marking lights, so that orientation among mechanized units and the direction of the attack can be maintained at night in smoke, bad weather, low visibility, and battlefield obscuration. Equipment has not only been designed and developed for this most pragmatic solution to reducing battlefield confusion at night and in bad weather, but their tactical literature describes in detail the use of this equipment. This indicates that they are working at developing a war-fighting capability at night.

Our operational vehicles are not similarly equipped with formation lights. Unit identification and route marking are left to field ex-

pedients and the ingenuity of the combat forces -- rags, toilet paper, taped over colored flashlights. This suggests that high intensity land combat by large mechanized forces at night and in bad weather has not been seriously attempted.

It will be necessary to equip combat vehicle with screened and colored marking lights, like those of the Warsaw Pact mechanized forces just to come even. However, there is the opportunity to jump ahead by applying advanced technology to this most essential combat actuality. Instead of lights route markings might respond to specific frequencies perhaps with some basic and variable coding. Lights, even when screened, are vulnerable to sensitive light amplification target acquisition devices. The markers suggested could be made dual mode -- basic visible light or discrete frequency on selection or command.

What is suggested here is that vehicle identification and route marking is too important and too critical in the future continuous land battle to be left to the ad hoc inventiveness of the forces who must meet the Soviet offensive. So many critical "too-hard" or "not yet considered" problems have simply been left to the operational units. These actualities of modern combat should be anticipated and advanced technology applied to provide the essential tools of war to our operational forces and not simply a few high technology weapons like, for example, a common launched guided projectile.

13.14. Advanced Forward Maintenance and Repair Concepts

The intensity of modern continuous combat was seen briefly in microcosm in the 1973 Arab-Israeli War (Under Secretary of the Army, Norman Augustine). In that war, the Israelis, using forward repair vans and very skilled cannibalizing, were able to repair and turn around more combat vehicles than they had to start the war. The Soviets document that 85% of all repairable equipment in WWII was repaired forward. This experience provides the basis for their repair-forward concepts and forward repair vehicles, equipment, crews, and training.

Continuous combat is enabled by the complete mechanization of land combat forces. The combatant who can best keep his vehicles operating and in combat will have a clear advantage.

Rear area and depot maintenance will have no effect on the immediate battle and in the continuous offensive that is projected by the Soviets may never have an opportunity to contribute at all. Yet peacetime operations, which are influenced by economy and industry practice and procedures, as well as the sustained war kind of experience that characterized the last wars, have established a body of experience on repair and maintenance that will have no bearing on modern continuous combat. In fact, it will have a negative effect in that resources spent on such "production line" procedures where forward teams perform only a triage function will detract from the very critical repair forward capability so critical to continuous combat.

Advanced technology can be applied, not only to the repair vehicles that are designed to survive in the combat zone, but in many areas hav-

ing to do with repair procedures and parts including secure, rapid data handling, presentation and retrieval. Forward repair and cannibalization demands a high level of skill and immediate information on interchangeability of parts, their availability and explicit "how-to-do-it" information for each repair unit forward. These repair teams will be under both time and combat stress, perhaps forced to wear protective masks and garments, and work under poor lighting conditions while exposed to the weather as well as combat hazards. The skill level of teams can be multiplied by computer based, self-learning, audio visual aids that can respond from a central data bank in real time to the requests and questions from many forward teams. The kind of information -- exploded views and the like -- that are available on microfisch in parts catalogs, could be extrapolated for the repair forward function and transmitted via secure data link perhaps by packetting. A computer maintenance teaching methodology has been developed at SRI in an early exploratory form. These techniques whereby the computer can respond to voice queries rather than going through a program or computer language might be useful in the concept described. It is in the areas of microprocessors, computers, and information handling that we have an advantage and excess capacity.

These are some of the concepts that might be used in advanced technology forward maintenance vehicles and concepts. While, on the surface, it may not have the topic appeal of scientifically novel research, it can be an advanced technology research area in every sense and it will have a major impact on combat effectiveness.

13.15. Advance Technology Use of Microprocessors to Improve Reliability, Survivability, and Maintainability of Combat Vehicles

The dependence on mechanization for continuous modern combat has been discussed as has the advantage that will accrue to the combatant who can keep his machines operating. In the "era of computational plenty" in which the United Stated has found itself microprocessors, large scale integration and small, high capacity, "low" cost computers and related technologies can be used extravagently. What inhibits their innovative application where they might have the greatest impact is the pre-conception that these sophisticated technologies are to be used on esoteric advanced technology weapons like guided missiles and not trucks and combat vehicles. Yet it is in the latter application that these technologies are likely to have their greatest impact on combat effectiveness.

Their capacity and low cost, and both going in the right direction, allow their profligate and innovative application. Some tentative efforts have been made in several automobile applications like the Volkswagen and similar computer diagnostic check-out systems. Certainly, applications like this are possible to detect brake pad and lining wear, bearing over-heat, magnetic chip detection and the like.

What might be done has more to do with multiplexing such information as oil temperature, pressure, fuel pressure, engine turns, and similar vehicle control and monitoring information on power conduits to eliminate the vulnerable, and costly, wire bundles.

The time consuming function in repair and replacement has to do with part and vehicle identification, forms, and procurement procedures, not to mention identifying by better than hit-and-miss methods what component needs repair and replacement. All this can be automated and be monitored by a central vehicle computer whose output might be a disk or magnetic strip which when inserted in the next echelon computer in the system, say at the forward maintenance van, could communicate the requirement as well as the vehicle location. The component could be sent forward or alternate instructions given contingent on the combat situation, all without manual processing. Even the link from vehicle to maintenance unit could be by data link. (This concept is described also in Section 9.)

These advanced technologies could have a maximum pay-off in vehicles that were designed specifically for combat and combat maintenance not borrowed from the automotive industry. The throwaway, major component replacement rather than repair and economy upkeep are opposite to peacetime procedures as is often the case. A machine built to function only in the combat environment must suit an entirely different set of criteria than one intended for a peacetime truck fleet. Miles per gallon is not nearly so important as reliability; ease of routine repair not as important and quick, modular replacement.

It seems reasonable, particularly as the pace of combat is increased by the lethality, mechanization, and mobility of combat forces, that these concepts might be tried in the design of a family of combat vehicles intended entirely and only for the purpose of combat and repair in the combat environment, with no other consideration permitted, not even as a secondary matter.

13.16. Other Recommendations

The following technology development recommendations that would be useful in improving effectiveness and enhancing our capability are presented as topic statements. Some amplification of these recommendations is presented in the appropriate sections of the report.

- Commander and command post simulation and training. Simulators and trainers have come a long way. An unknown and unexplored area is the training of battle commanders. In past wars we had time to train on the job. In a short war these commanders in the field must already have been there. Viet Nam combat experience has no application.

- EW training is a whole area. Right now it is special. In a war with the Soviets it will be just as normal as a rifle fire (jamming, deception, chaff, etc.).

- Advanced decontamination and wash down systems for chemical, nuclear, biological warfare. (Soviet's already have.)

- Combat uniforms for CBR; one way breathing material using NASA technology. Normal wear -- not special protective gear to put on when there is an alarm.

- Use of RPVs to dispense chaff on top of the air defense system, in pairs, flying self-protecting S-patterns. Done this way the strong outgoing radar bang is blocked as well as the weak return echos.

- Cheap RPV decoys used in large numbers to confound fast acting air defense weapons and use up their ammunition.

- Use of microprocessor and signal procesing to eliminate wire bundles in aircraft, helicopters, and advanced combat vehicles.

- Multiple automatic communications repeaters to present the enemy the problem "which is the communicator to shoot at?"

- Deception warfare to duplicate high mobility combat forces, confuse the combat picture, and dilute the enemy's response.

- Use of RPVs to lay chaff, smoke, and dispersants; blind the enemy.

- The trend is to low profile, high mobility combat vehicles. this is good for survivability, bad for seeing. Periscope systems using conventional optics are costly and fragile. Fiber optics; planar infinite focus mosiacs; small low cost tv; other.

- Real time target acquisition and surveillance systems capable of detecting major systems of war in real time as opposed to fine grain detail much too late to matter: side looking synthetic aperature, communications and electronic emission detection systems, IR, moving target doppler, rotor blade detection doppler. System airborne in RPV (not in AWACS) coupled by dish to dish microwave data link; gathered data stored and processed by artificial intelligence techniques; displayed as symbology in near real time in command post.

- Some actualities of high intensity continuous warfare. There will be no pause to recover the wounded. Soviets are training dogs. Perhaps cooperative transponders using a dead man's switch idea.

- Heading and navigation systems for military vehicles. Soviets have. We don't. A modular approach would be sensible. We are holding up systems in R & D waiting for a quantum jump improvement.

- Modified Common Launched Guided Projectile using terminal guidance against self-propelled artillery. Integration of the combat vehicle inherent microwave emanation for mid-course rough guidance, with final terminal guidance on a limited traverse IR seeker might be an approach to consider.

- All infantry antitank guided missiles -- TOW, DRAGON, MILAN, HOT -- are soft. They won't live in a Warsaw Pact battlefield environment. A brute force solution is to put TOW on a M113 chassis. There should be better solutions.

- Logistics resupply and rearm is a weak link in battlefield systems; ammo comes in cases that must be uncrated. The resupply vehicle that is married to a hard self-propelled artillery piece has a soft top. It can't live in the same environment as the vehicle it supports.

Acronyms and Abbreviations

ADP	Automatic Data Processing
AIT	Advanced Individual Training
ARPA	Defense Advanced Research Projects Agency
ARTEP	Army Training and Evaluation Program
ASW	Antisubmarine Warfare
AWACS	Air Warning and Control Systems
BCT	Basic Combat Training
BIFF	Battlefield Identification Friend or Foe
BITE	Built-in Test Equipment
BOIP	Basis Of Issue Plan
CACDA	U.S. Army Combined Arms Combat Developments Activity, Fort Leavenworth
CAS	Close Air Support
CBR	Chemical, Biological, Radiological
Chast'	A Soviet term which designates any unit of regimental or smaller size that is administratively self-contained or separately numbered
COMINT	Communications Intelligence
CONUS	Continental United States
DARCOM	U.S. Army Development and Readiness Command
DDRE	Department of Defense Research and Engineering
DISCOM	Division Support Command
DoD	Department of Defense
DRSG	Division Restructuring Study Group

ECM	Electromagnetic Counter Measures
FAC	Forward Air Controller
FAALS	Field Artillery Acoustic Array Locating System
FAAR	Forward Area Alerting Radar
FEBA	Forward Edge of the Battle Area
FM	Field Manual
FORSCOM	U.S. Army Forces Command
FRG	Federal Republic of Germany
FROG	Free-Rocket-Over-The-Ground
FTX	Field Training Exercises
GSFG	Group of Soviet Forces Germany
IAF	Israeli Air Force
IDF	Israeli Defense Force
IR	Infrared
LOC	Line-of-Communications
MBA	Main Battle Area
MICV	Mechanized Infantry Combat Vehicle
MRD	Motorized Rifle Division
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Chemical, Biological
PGM	Precision Guided Munition
Podrazdedeniye	Russian term for "subdivision" it is used to refer to a subordinate unit of a chast'; it is any unit which cannot be identified numerically except by reference to a larger unit of which it is a part

POL	Petroleum, Oils, Lubricants
Project MASSTER	Modern Army Selected System Test Evaluation and Review
PTURS	Soviet Antitank Guided Missile
PVO	Air Defense Command
ROTC	Reserve Officer Training Corps
SAC	Strategic Air Command
SACEUR	Supreme Allied Command Europe
SAM	Surface-to-Air Missile
SHORADS	Short Range Air Defense System
SIGINT	Signals Intelligence
SRI	Stanford Research Institute now SRI - International
SSM	Surface-to-Surface Missile
STANO	Surveillance, Target Acquisition and Night Observation
TAC	Tactical Air Command
TOE	Tables of Organization and Equipment
TRADOC	U.S. Army Training and Doctrine Command

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This report presents the results of a study of continuous land combat, a concept of modern warfare made possible by the complete mechanization of land combat forces and the technology that enables effective combat at night, in poor weather, and under low visibility conditions. It is a logical extension of the blitzkreig warfare of the German Armies in World War II.

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20 ABSTRACT (Continued)

An abbreviated comparison is made of current U.S. perception of and capabilities for the conduct and support of continuous land combat with the land and air force needs to achieve that capability. A systems perspective was taken in examining combat and combat supporting functions and the essential elements of a continuous combat capability -- doctrine, organization, training, equipment and technology. An effort was made to gain the participation and input of those operational and development organizations that are concerned with various aspects of continuous land combat operations.